PATENT ABSTRACTS OF JAPAN

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SHINOHARA ETSUO
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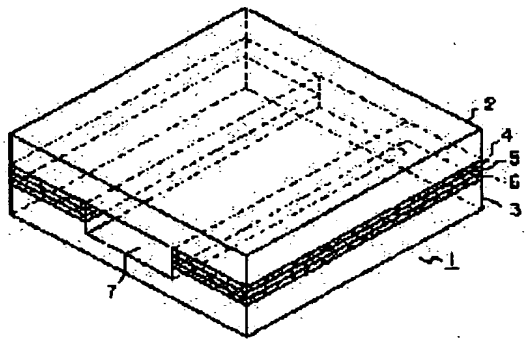
(54) FINE PASSAGE ELEMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a fine passage el ment having an apparatus analyzing fluid passage allowing optical detection over a wavelength range from ultraviolet rays to visual rays and capable of being easily miniaturized.
SOLUTION: This fine passage element 1 is connected with a flat quartz glass substrate 2 and a quartz glass substrate 3 formed with a groove at least on one face via a laminated film constituted of a polysilicone thin film 4, an alkali ion-containing glass layer, e.g. a boro-silicate glass thin film 5, and a polysilicone thin film 6. An apparatus analyzing fluid passage 7 is formed with the space surrounded by the quartz glass substrate 2 and the quartz glass substrate 3 formed with the groove, the fluid passage 7 is formed on the quartz glass substrate excellent in light permeability in the wavelength range from ultraviolet rays to visible rays, and optical detection can be made in the wavelength range from ultraviolet rays to visible rays.



LEGAL STATUS

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JAPANESE [JP,10-288580,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS DESCRIPTION OF DRAWINGS DRAWINGS CORRECTION OR AMENDMENT

[Translation done.]

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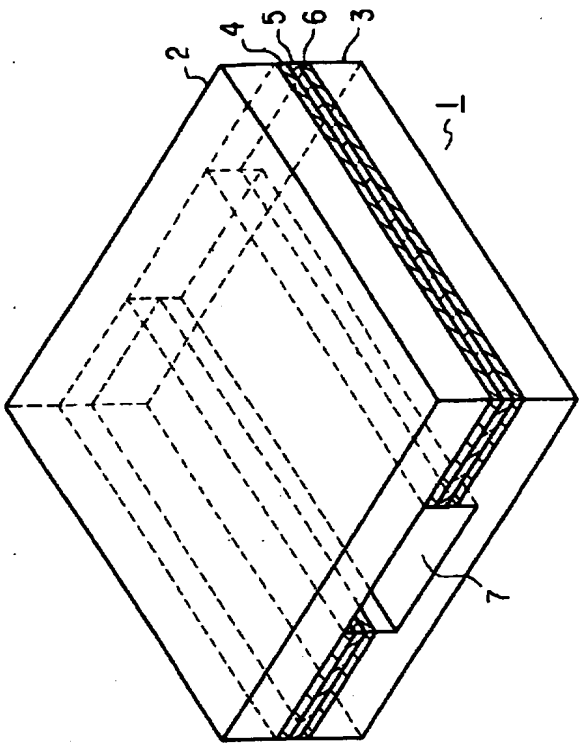
CLAIMS

[Claim(s)]
[Claim 1] In respect of a side which a quartz-glass substrate of a pair with which a slot where a side [it counters] forms passage in a field on the other hand at least is prepared, and a quartz-glass substrate of said pair counter A minute passage element characterized by intervening between a silicon layer of a pair formed on a field which confronts each other, and a silicon layer of said pair, providing an alkali ion content glass layer formed in contact with both silicon layer except for a field which touches a opening of said slot inside and this slot, and being joined in one.
[Claim 2] In respect of a side which a quartz-glass substrate of a pair with which a slot where a side [it counters] forms passage in a field on the other hand at least is prepared, and a quartz-glass substrate of said pair counter A silicon layer of a pair formed on a field which confronts each other except for a field which touches a opening of said slot inside and this slot, An alkali ion content glass layer which intervenes between silicon layers of said pair and is formed in contact with one silicon layer, A minute passage element characterized by intervening between silicon layers of said pair, providing silicon oxide formed in contact with a silicon layer of another side, and said alkali ion content glass layer, and being joined in one.
[Claim 3] Claim 1 characterized by preparing a reflective film in one [at least] external surface by the side of a non-plane of composition of a quartz-glass substrate of said minute passage element, or a minute passage element according to claim 2.

[Translation done.]

Drawing selection | Representative drawing



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the fluid passage for instrumental analyses which used the glass substrate.
[0002]
[Description of the Prior Art] Generally, the fluid passage for instrumental analyses is constituted using capillaries, such as glass and stainless steel.
[0003] In order that this capillary might raise analysis capacity, it was usually used by length of about 50cm, but since this capillary was used rounding off it in the shape of a circle, the miniaturization was difficult.
[0004] Conventionally, the technology which forms a detailed slot in a silicon substrate etc. is reported, using a semiconductor manufacturing technology as a means to miniaturize. However, by the silicon substrate which consists of a semiconductor, when it was going to use for the capillary electrophoresis which dissociates by impressing the high voltage, in order that current might leak, there was a trouble that the high voltage could not be impressed.
[0005] Then, a detailed slot is processed into the glass substrate of an insulating material as fluid passage for instrumental analyses which leak of current does not produce, and the method of forming passage is learned.
[0006] For example, after performing recessing to a borosilicate glass substrate, it is carried by "Micromachining of Capillary Electrophoresis Injectors and Separators on Glass Chips and Evaluation of Flow at Capillary Interse" (Anal.Chem.1994, 66, and P177-184) about the passage which welded and formed this borosilicate glass substrate with heating.
[0007] This recessing forms a metal vacuum evaporationo film to a borosilicate glass substrate, after it carries out patterning of the metal membrane with photolithography technology, it mak s a borosilicate glass substrate immersed in the solution which mixed fluoric acid, using this metal membrane as a mask, is etched, and forms U slot. Furthermore, the flat borosilicate glass substrate is heated and borosilicate glass welded [which carried out recessing] to superposition and 700 degrees C so that U slot may be plugged up.
[0008] To moreover, others "A New Fbrication Method of Borosilicate Glass Capillary Tubes with A slot is formed in a borosilicate glass substrate at Lateral Inlets and Outlets" (Analytical Methods & Instrumentation, Special Issue muTAS'96 p214). The technology which joins this borosilicate glass substrate and other flat borosilicate glass substrates with an anode plate conjugation method, and forms passage is indicated.
[0009] After make a borosilicate-glass substrate form a polish recon (poly-Si) thin film and carrying out patterning of the polish recon thin film with low-voltage chemical vapor growth (LPCVD) using photolithography technology to it, recessing makes a borosilicate-glass substrate immersed in the solution which mixed fluoric acid by using this polish recon thin film as a mask, etches, and, according to this technology, forms a slot.

[0010] And anode plate cementation is joined with heating, making voltage impress between the polish recon thin film on one borosilicate glass substrate, and the borosilicate glass substrate of another side.
[0011]
[Problem(s) to be Solved by the Invention] When carrying out separation analysis of the liquid conventionally using the fluid passage for instrumental analyses, detection of separation material is technique with common optical detection. As a substrate which constitutes the fluid passage for instrumental analyses, since borosilicate glass was used for both the conventional technology mentioned above, it absorbed the light of an ultraviolet wavelength region and had the trouble that optical detection in a short wavelength region could not be performed.
[0012] Then, this invention is crossed to a visible wavelength region from ultraviolet, and aims at offering the minute passage element which has easily the fluid passage for instrumental analyses which can be miniaturized possible [optical detection].
[0013]
[Means for Solving the Problem] This invention is the near field where a quartz-glass substrate of a pair with which a slot where a side [it counters] forms passage in a field on the other hand at least is prepared, and a quartz-glass substrate of said pair counter, in order to attain the above-mentioned purpose. It intervenes between a silicon layer of a pair formed on a field which confronts each other except for a field which touches a opening of said slot inside and this slot, and a silicon layer of said pair, and it has an alkali ion content glass layer formed in contact with both silicon layer, and a minute passage element joined in one is offered.
[0014] Furthermore, this minute passage element equips a location by the side of a non-plane of composition of a quartz-glass substrate joined face to face applied to said passage on the other hand at least in a field with either a light reflex layer which has two or more openings, or a light absorption layer.
[0015] A slot (fluid passage) is formed in a quartz-glass substrate the above minute passage elements of a configuration excelled [substrate] in the permeability of light of a visible wavelength region from ultraviolet, and optical detection is attained in a wavelength region visible from ultraviolet. Moreover, in order to form detailed fluid passage on a quartz-glass substrate using a semiconductor manufacturing technology, a minute passage element is miniaturized.
[0016]
[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained to details with reference to a drawing.
[0017] The rough configuration of the minute passage element as 1st operation gestalt by this invention is shown in drawing 1 , and it explains to it.
[0018] This minute passage element 1 makes the cascade screen which the flat quartz-glass substrate 2 and the quartz-glass substrate 3 with which the slot was formed in one [at least] field become from the polish recon thin film 4, the alkali ion content glass layer 5, for example, a borosilicate glass thin film, and the polish recon thin film 6 intervene, and is joined and constituted. Of the space surrounded by this quartz substrate 2 and the quartz-glass substrate 3 by which the slot was formed, the fluid passage 7 for instrumental analyses (fluid passage is called hereafter) is formed.
[0019] Next, with reference to drawing 2 (a) - (h) and drawing 3 (a) - (f), the formation production process of a minute passage element is explained.
[0020] First, as shown in drawing 2 (a), LPCVD is used on all the surfaces of the quartz-glass substrate 2, and the polish recon thin film 4 of a non dope is formed. In this operation gestalt, the thickness of the quartz-glass substrate 2 has the desirable quartz substrate 1mm or less which carried out double-sided polishing, and the thickness of the polish recon thin film 4 is 1 micrometer. It is desirable that it is the following.
[0021] Next, as shown in drawing 2 (b), the borosilicate glass thin film 5 is formed by sputtering

on one surface of said polish recon thin film 4. The thickness of this borosilicat glass thin film 5 is 1 micrometer. It is desirable that it is the following. As furthermore shown in drawing 2 (c), the spin coat of the positive type photoresist is carried out to the surface of the borosilicate glass thin film 5, and the resist film 8 is formed on it.

[0022] As shown in drawing 2 (d), with photolithography technology, patterning of the resist film 8 is carried out, and resist mask 8a is formed. As shown in drawing 2 (e), after removing th borosilicate glass thin film 5 exposed in the field except having been covered with resist mask 8a and removing the polish recon thin film 4 of further a lower layer by anisotropic etching (RIE), for example, reactive ion etching, as shown in drawing 2 (f), by the plasma asher, resist mask 8a is removed and the passage configuration substrate 10 which has a slot 9 is formed.

[0023] Next, as shown in drawing 2 (g), the polish recon thin film 6 of a non dope is formed by LPCVD on all the surfaces of another quartz-glass substrate 3. For this quartz-glass substrate 3, the thickness of the polish recon thin film 6 which the quartz substrate with a thickness of 1mm or less which carried out double-sided polishing is desirable, and forms is 1 micrometer. It is desirable that it is the following.

[0024] Next, as shown in drawing 2 (h), after carrying out the spin coat of the positive type photoresist to the surface of the polish recon thin film 6 and forming the resist thin film 11, as shown in drawing 3 (a), patterning of the resist mask 11a is carried out with photolithography technology.

[0025] And after removing the polish recon thin film 6 exposed by RIE, as are shown in drawing 3 (b), and it is shown in drawing 3 (c) by using resist mask 11a as a mask, a plasma asher removes resist mask 11a.

[0026] Next, as shown in drawing 3 (d), wet etching removes the portion which the quartz-glass substrate 3 exposed to the solution which mixed fluoric acid and ammonium fluoride, using as a mask the polish recon thin film 6 which was immersed and carried out patterning of the quartz-glass substrate 3, and the passage configuration substrate 13 which has a slot 12 is formed. For this slot 12, the depth of flute or width of face is 100 micrometers. It is desirable that it is the following.

[0027] Furthermore, as shown in drawing 3 (e), it piles up so that the amount of [of said passage configuration substrate 10 and the passage configuration substrate 13] slot may agree, and it joins using an anode plate conjugation method, and the element substrate 14 is formed.

[0028] This anode plate cementation is performed by heating the whole substrate, impressing voltage between the polish recon thin film 4 and the polish recon thin film 6. The heating temperature at this time is about 350-500 degrees C, and applied voltage is 200-1000 (V). It is desirable.

[0029] Next, as shown in drawing 3 (f), RIE or wet etching removes the polish recon thin film of the surface of the joined element substrate 14 which is shown in this drawing (e), and the minute passage element 1 is constituted.

[0030] Although the silicon layer which consists of a polish recon thin film was used with this operation gestalt, you may be an amorphous silicon thin film, and this silicon thin film has a desirable non dope silicon thin film. Membrane formation of a silicon thin film can apply and form semiconductor membrane formation technology, such as not only LPCVD but plasma CVD, sputtering, ECR, vacuum evaporationo, etc. Moreover, although said slot is linear [-like], it may not be limited to it, may be a curvilinear configuration, or may be a wave-like. Moreover, the depth of flute or width of face is 150 micrometers. It is desirable that it is the following and the sentiment and dry etching which used semiconductor technology, m chanical processing, etc. can be used for recessing.

[0031] Although the borosilicate glass thin film was used as an alkali ion content glass layer with this operation gestalt, you may be a soda glass thin film etc.

[0032] Thus, since the slot (fluid passage) is formed in the quartz-glass substrate excellent in the permeability of the light of a visible wavelength region from ultraviolet, as for the constituted

minute passage element 1, optical detection is attained in a wavelength region visible from ultraviolet. For this minute passage element 1, it mainly consists of glass, and a silicon thin film is a non dope silicon thin film, and thickness is 1 micrometer. Since it is that of the following, when high-voltage impression is carried out as passage for capillary el ctrophoreses, leak of current which affects electrophoresis does not arise. Moreover, with this operation gestalt, since semiconductor process technology is applied, formation of detailed slot passage becomes easy and the miniaturization of a minute passage element can be realized.

[0033] Next, the rough configuration of the minute passage element as 2nd operation gestalt is shown in drawing 4 , and it explains to it. Here, the same reference mark is given to the part equivalent to the configuration part and the configuration part of this operation gestalt which were shown in drawing 1 .

[0034] This minute passage element 20 makes the cascade screen which the flat quartz-glass substrate 2 and the quartz-glass substrate 3 with which the slot was formed in one [at least] field become from the polish recon thin film 4, the alkali ion content glass layer 5, for example, a borosilicate glass thin film, silicon oxide (Si O2) 21, and the polish recon thin film 6 intervene, and is joined and constituted. The fluid passage 7 is formed of the space surrounded by this quartz-glass substrate 2 and the quartz-glass substrate 3 by which the slot was formed.

[0035] This minute passage element 20 is created by adding the production process which forms silicon oxide 21 by sputtering on the surface of the borosilicate glass thin film 5 between the drawing 2 (b) production processes and the (c) production processes which were mentioned above. At this time, the thickness of silicon oxide 21 is 500 micrometers. The following is desirable.

[0036] It becomes easy to join it, in order that such a minute passage element 20 may prevent the current leak by dielectric breakdown in the case of anode plate cementation in addition to the effect of the minute passage element 1 in the 1st operation gestalt mentioned above since the silicon oxide 21 which is an insulating material was made to intervene between the borosilicate glass thin film 5 and the polish recon thin film 6. Moreover, since the high voltage impresses between the polish recon thin film 4 and the polish recon thin film 6 and it becomes cheap at coincidence, it becomes thin to join the thickness of the borosilicate glass thin film 5 easy.

[0037] Next, drawing 5 shows the rough configuration of the minute passage element as 3rd operation gestalt.

[0038] This minute passage element 30 is the example of a configuration in which the polish recon thin film 31 was formed to one field of the minute passage element 20 of the 2nd operation gestalt. This minute passage element 30 can be formed in the drawing 3 (e) production process mentioned above by leaving without removing one polish recon thin film 4 or polish recon thin film 6 of a field, and removing the polish recon thin film of an another side side. In drawing 5 , the example which has left the polish recon thin film 6 (31) is shown.

[0039] Thus, since the constituted minute passage element 30 forms the polish recon thin film 31 in one field, It adds to an operation and effect of the minute passage element 1 mentioned above and the minute passage element 20. A light emitting device and a photo detector are prepared in the quartz-glass substrate 2 side of a minute passage element top, incidence of the detection light is carried out from the quartz-glass substrate 2 side, in case the reflected light is detected and analyzed, the reflection factor of light becomes high and detection sensitivity improves.

[0040] In addition, in this operation gestalt, other members can be used for th polish recon thin film 31 as a reflective film of light, for example, metal thin films, such as aluminum, may be used for it, for example.

[0041] Next, drawing 6 shows the rough configuration of the minute passage element as 4th operation gestalt.

[0042] Moreover, the upper surface of the minute passage element 40 of this operation gestalt

is shown in drawing 7 (a), and the A-A cross section of this drawing (a) is shown in drawing 7 (b). However, let th inferior surface of tongue of the minute passage element 40 be a thing equivalent to the configuration of the upper surface of drawing 6 . Here, the same refer nce mark is given to the part equivalent to the configuration part shown in the configuration part and drawing 5 of this operation gestalt.

[0043] This minute passage element 40 is the configuration which the polish recon thin film 31 and the polish recon thin film 41 were formed in both sides of the minute passage element 20 mentioned above, and formed two or more apertures 42 in the symmetrical location of the polish recon thin films 31 and 41 which are the direction of the fluid passage 7, and the direction which intersects perpendicularly, and face across this fluid passage 7.

[0044] These apertures 42a-42f and -- carry out incidence of the light from one field, and in order to function as an aperture for observation which detects the transmitted light from the field of another side, even if it does not condense especially detection light, they become detectable [the material which passes through the specific part of passage] in the case of optical analysis. Analysis of minute area is attained by making especially the aperture 42 minute.

[0045] Next, with reference to the formation production process of drawing 8 (a) - (e), formation of said minute passage element 40 is explained.

[0046] First, as shown in drawing 8 (a), the configuration of this operation gestalt is the element substrate which formed at the formation production process of the 2nd operation gestalt shown in drawing 4 mentioned above, and the same formation production process, and silicon oxide 21 was made to intervene between the passage configuration substrate 10 shown by drawing 3 (e), and the passage configuration substrate 13, and was joined using the anode plate conjugation method.

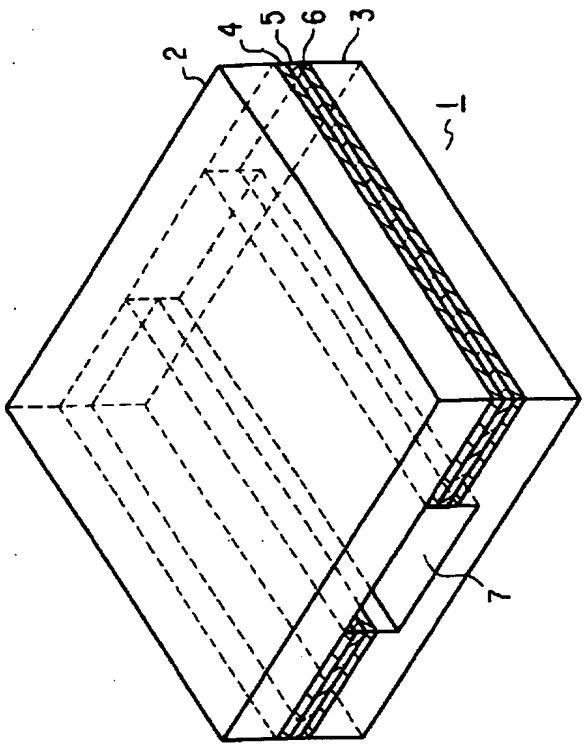
[0047] Next, as shown in drawing 8 (b), the spin coat of the photoresist is carried out on each surface of the polish recon thin films 4 and 6 which have covered both sides of the element substrate joined in this drawing (a), and the resist thin film 8 is formed.

[0048] And as shown in drawing 8 (c), patterning is carried out to the configuration of an aperture 42 where the resist thin film 8 is shown in drawing 6 , using photolithography technology, and resist mask 8a is formed. As shown in drawing 8 (d), a part for the outcrop of the polish recon thin films 4 and 6 is removed using RIE by using resist mask 8a as a mask, and the polish recon thin films 4 and 6 which have an aperture 42 are formed.

[0049] Furthermore, as shown in drawing 8 (e), by the plasma asher, resist mask 8a is removed and the minute passage element 40 which has three apertures 42 to both sides, respectively is formed. Here, although the polish recon thin film of element both sides was illustrated in the condition of having been connected with the polish recon thin film of a substrate plane of composition, as shown in drawing 7 (b), the double-sided polish recon thin film 31 and the polish recon thin films 4 and 6 of a plane of composition may be separated on the side.

[0050]

Drawing selection | R pres ntative drawing



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JAPANESE [JP,10-288580,A]

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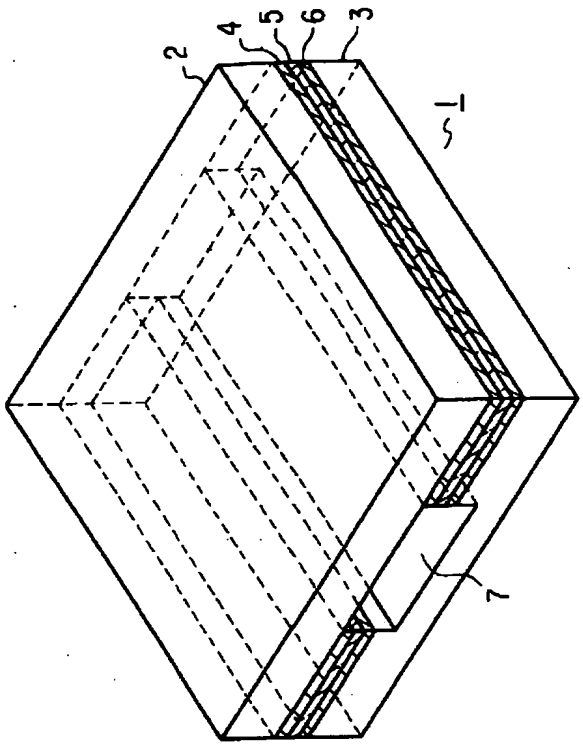
Drawing selection Repr sentativ drawing



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PRIOR ART

[Description of the Prior Art] Generally, the fluid passage for instrumental analyses is constituted using capillaries, such as glass and stainless steel.
[0003] In order that this capillary might raise analysis capacity, it was usually used by length of about 50cm, but since this capillary was used rounding off it in the shape of a circle, the miniaturization was difficult.
[0004] Conventionally, the technology which forms a detailed slot in a silicon substrate etc. is reported, using a semiconductor manufacturing technology as a means to miniaturize. However, by the silicon substrate which consists of a semiconductor, when it was going to use for the capillary electrophoresis which dissociates by impressing the high voltage, in order that current might leak, there was a trouble that the high voltage could not be impressed.
[0005] Then, a detailed slot is processed into the glass substrate of an insulating material as fluid passage for instrumental analyses which leak of current does not produce, and the method of forming passage is learned.
[0006] For example, after performing recessing to a borosilicate glass substrate, it is carried by "Micromachining of Capillary Electrophoresis Injectors and Separators on Glass Chips and Evaluation of Flow at Capillary Interse" (Anal.Chem.1994, 66, and P177-184) about the passage which welded and formed this borosilicate glass substrate with heating.
[0007] This recessing forms a metal vacuum evaporationo film to a borosilicate glass substrate, after it carries out patterning of the metal membrane with photolithography technology, it makes a borosilicate glass substrate immersed in the solution which mixed fluoric acid, using this metal membrane as a mask, is etched, and forms U slot. Furthermore, the flat borosilicate glass substrate is heated and borosilicate glass welded [which carried out recessing] to superposition and 700 degrees C so that U slot may be plugged up.
[0008] To moreover, others "A New Fbrication Method of Borosilicate Glass Capillary Tubes with A slot is formed in a borosilicate glass substrate at Lateral Inlets and Outlets" (Analytical Methods & Instrumentation, Special Issue muTAS'96 p214). The technology which joins this borosilicate glass substrate and other flat borosilicate glass substrates with an anode plate conjugation method, and forms passage is indicated.
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[0010] And anode plate cementation is joined with heating, making voltage impress between the polish recon thin film on one borosilicate glass substrate, and the borosilicate glass substrate of another side.

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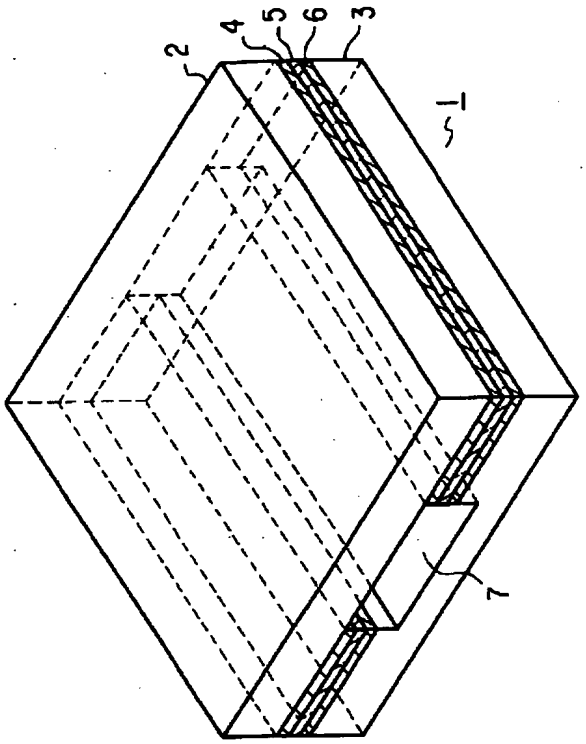

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EFFECT OF THE INVENTION

[Effect of the Invention] As explained in full detail above, according to this invention, it can cross to a visible wavelength region from ultraviolet, and the minute passage element which has easily the fluid passage for instrumental analyses which can be miniaturized possible [optical d tection] can be offered.

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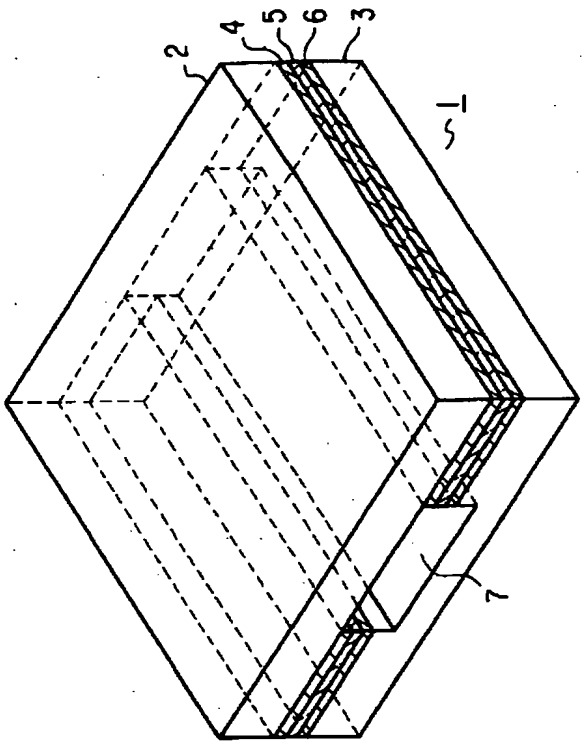

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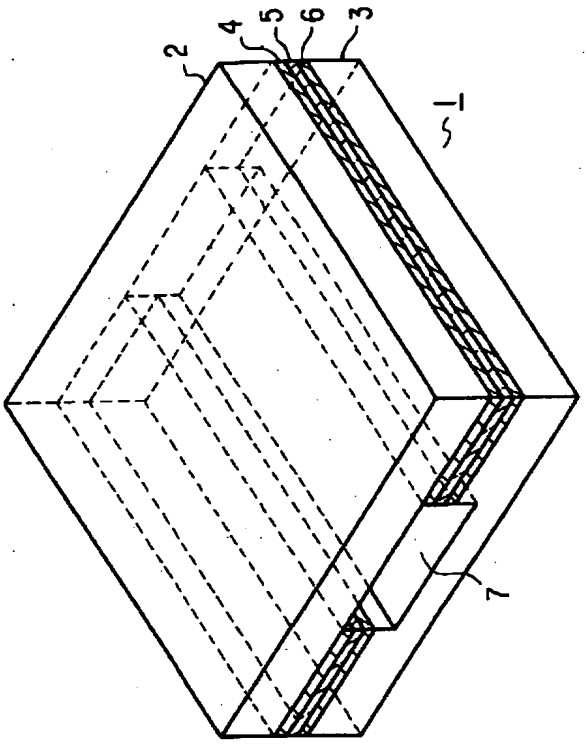

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MEANS

[Means for Solving the Problem] This invention is the near field where a quartz-glass substrate of a pair with which a slot where a side [it counters] forms passage in a field on the other hand at least is prepared, and a quartz-glass substrate of said pair counter, in order to attain the above-mentioned purpose. It intervenes between a silicon layer of a pair formed on a field which confronts each other except for a field which touches a opening of said slot inside and this slot, and a silicon layer of said pair, and it has an alkali ion content glass layer formed in contact with both silicon layer, and a minute passage element joined in one is offered.
[0014] Furthermore, this minute passage element equips a location by the side of a non-plane of composition of a quartz-glass substrate joined face to face applied to said passage on the other hand at least in a field with either a light reflex layer which has two or more openings, or a light absorption layer.
[0015] A slot (fluid passage) is formed in a quartz-glass substrate the above minute passage elements of a configuration excelled [substrate] in the permeability of light of a visible wavelength region from ultraviolet, and optical detection is attained in a wavelength region visible from ultraviolet. Moreover, in order to form detailed fluid passage on a quartz-glass substrate using a semiconductor manufacturing technology, a minute passage element is miniaturized.
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[0018] This minute passage element 1 makes the cascade screen which the flat quartz-glass substrate 2 and the quartz-glass substrate 3 with which the slot was formed in one [at least] field become from the polish recon thin film 4, the alkali ion content glass layer 5, for example, a borosilicate glass thin film, and the polish recon thin film 6 intervene, and is joined and constituted. Of the space surrounded by this quartz substrate 2 and the quartz-glass substrate 3 by which the slot was formed, the fluid passage 7 for instrumental analyses (fluid passage is called hereafter) is formed.
[0019] Next, with reference to drawing 2 (a) - (h) and drawing 3 (a) - (f), the formation production process of a minute passage element is explained.
[0020] First, as shown in drawing 2 (a), LPCVD is used on all the surfaces of the quartz-glass substrate 2, and the polish recon thin film 4 of a non dope is formed. In this operation gestalt, the thickness of the quartz-glass substrate 2 has the desirable quartz substrate 1mm or less which carried out double-sided polishing, and the thickness of the polish recon thin film 4 is 1 micrometer. It is desirable that it is the following.
[0021] Next, as shown in drawing 2 (b), the borosilicate glass thin film 5 is formed by sputtering on one surface of said polish recon thin film 4. The thickness of this borosilicate glass thin film 5

is 1 micrometer. It is desirable that it is the following. As furthermore shown in drawing 2 (c), the spin coat of the positive typ photoresist is carried out to the surface of the borosilicat glass thin film 5, and th r sist film 8 is formed on it.

[0022] As shown in drawing 2 (d), with photolithography technology, patterning of th resist film 8 is carried out, and resist mask 8a is formed. As shown in drawing 2 (e), after removing th borosilicate glass thin film 5 xposed in the field except having been covered with resist mask 8a and removing the polish recon thin film 4 of further a lower layer by anisotropic etching (RIE), for example, reactive ion etching, as shown in drawing 2 (f), by the plasma asher, resist mask 8a is removed and the passage configuration substrate 10 which has a slot 9 is formed.

[0023] Next, as shown in drawing 2 (g), the polish recon thin film 6 of a non dope is formed by LPCVD on all the surfaces of another quartz-glass substrate 3. For this quartz-glass substrat 3, the thickness of the polish recon thin film 6 which the quartz substrate with a thickness of 1mm or less which carried out double-sided polishing is desirable, and forms is 1 micrometer. It is desirable that it is the following.

[0024] Next, as shown in drawing 2 (h), after carrying out the spin coat of the positive type photoresist to the surface of the polish recon thin film 6 and forming the resist thin film 11, as shown in drawing 3 (a), patterning of the resist mask 11a is carried out with photolithography technology.

[0025] And after removing the polish recon thin film 6 exposed by RIE, as are shown in drawing 3 (b), and it is shown in drawing 3 (c) by using resist mask 11a as a mask, a plasma asher removes resist mask 11a.

[0026] Next, as shown in drawing 3 (d), wet etching removes the portion which the quartz-glass substrate 3 exposed to the solution which mixed fluoric acid and ammonium fluoride, using as a mask the polish recon thin film 6 which was immersed and carried out patterning of the quartz-glass substrate 3, and the passage configuration substrate 13 which has a slot 12 is formed. For this slot 12, the depth of flute or width of face is 100 micrometers. It is desirable that it is the following.

[0027] Furthermore, as shown in drawing 3 (e), it piles up so that the amount of [of said passage configuration substrate 10 and the passage configuration substrate 13] slot may agree, and it joins using an anode plate conjugation method, and the element substrate 14 is formed.

[0028] This anode plate cementation is performed by heating the whole substrate, impressing voltage between the polish recon thin film 4 and the polish recon thin film 6. The heating temperature at this time is about 350-500 degrees C, and applied voltage is 200-1000 (V). It is desirable.

[0029] Next, as shown in drawing 3 (f), RIE or wet etching removes the polish recon thin film of the surface of the joined element substrate 14 which is shown in this drawing (e), and the minute passage element 1 is constituted.

[0030] Although the silicon layer which consists of a polish recon thin film was used with this operation gestalt, you may be an amorphous silicon thin film, and this silicon thin film has a desirable non dope silicon thin film. Membrane formation of a silicon thin film can apply and form semiconductor membrane formation technology, such as not only LPCVD but plasma CVD, sputtering, ECR, vacuum evaporationo, etc. Moreover, although said slot is linear [-like], it may not be limited to it, may be a curvilinear configuration, or may be a wave-like. Moreover, the depth of flute or width of face is 150 micrometers. It is desirable that it is the following and the sentiment and dry etching which used semiconductor technology, mechanical processing, etc. can be used for recessing.

[0031] Although the borosilicate glass thin film was used as an alkali ion content glass layer with this operation gestalt, you may be a soda glass thin film etc.

[0032] Thus, since the slot (fluid passage) is formed in the quartz-glass substrate excellent in the permeability of the light of a visible wavelength region from ultraviolet, as for the constituted minute passage element 1, optical detection is attained in a wavelength region visible from

ultraviolet. For this minute passage element 1, it mainly consists of glass, and a silicon thin film is a non dope silicon thin film, and thickness is 1 micrometer. Since it is that of the following, when high-voltage impression is carried out as passage for capillary l ctrophoreses, leak of current which affects electrophoresis does not arise. Moreover, with this operation gestalt, since semiconductor process technology is applied, formation of detailed slot passage becomes easy and the miniaturization of a minute passage element can be r alized.

[0033] Next, the rough configuration of the minute passage element as 2nd operation gestalt is shown in drawing 4 , and it explains to it. Here, the same reference mark is given to the part equivalent to the configuration part and the configuration part of this operation gestalt which w re shown in drawing 1 .

[0034] This minute passage element 20 makes the cascade screen which the flat quartz-glass substrate 2 and the quartz-glass substrate 3 with which the slot was formed in one [at least] field become from the polish recon thin film 4, the alkali ion content glass layer 5, for example, a borosilicate glass thin film, silicon oxide (Si O2) 21, and the polish recon thin film 6 intervene, and is joined and constituted. The fluid passage 7 is formed of the space surrounded by this quartz-glass substrate 2 and the quartz-glass substrate 3 by which the slot was formed.

[0035] This minute passage element 20 is created by adding the production process which forms silicon oxide 21 by sputtering on the surface of the borosilicate glass thin film 5 between th drawing 2 (b) production processes and the (c) production processes which were mentioned above. At this time, the thickness of silicon oxide 21 is 500 micrometers. The following is desirable.

[0036] It becomes easy to join it, in order that such a minute passage element 20 may prevent th current leak by dielectric breakdown in the case of anode plate cementation in addition to the effect of the minute passage element 1 in the 1st operation gestalt mentioned above since the silicon oxide 21 which is an insulating material was made to intervene between the borosilicate glass thin film 5 and the polish recon thin film 6. Moreover, since the high voltage impresses between the polish recon thin film 4 and the polish recon thin film 6 and it becomes cheap at coincidence, it becomes thin to join the thickness of the borosilicate glass thin film 5 easy.

[0037] Next, drawing 5 shows the rough configuration of the minute passage element as 3rd operation gestalt.

[0038] This minute passage element 30 is the example of a configuration in which the polish recon thin film 31 was formed to one field of the minute passage element 20 of the 2nd operation gestalt. This minute passage element 30 can be formed in the drawing 3 (e) production process mentioned above by leaving without removing one polish recon thin film 4 or polish recon thin film 6 of a field, and removing the polish recon thin film of an another side side. In drawing 5 , the example which has left the polish recon thin film 6 (31) is shown.

[0039] Thus, since the constituted minute passage element 30 forms the polish recon thin film 31 in one field, It adds to an operation and effect of the minute passage element 1 mentioned above and the minute passage element 20. A light emitting device and a photo detector are prepared in the quartz-glass substrate 2 side of a minute passage element top, incidence of the detection light is carried out from the quartz-glass substrate 2 side, in case the reflected light is detected and analyzed, the reflection factor of light becomes high and detection sensitivity improves.

[0040] In addition, in this operation gestalt, other members can be used for the polish recon thin film 31 as a reflective film of light, for example, metal thin films, such as aluminum, may be used for it, for example.

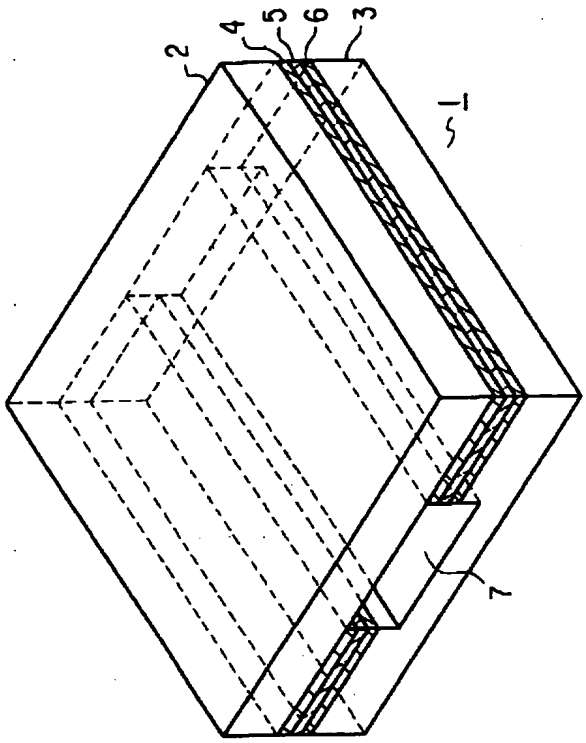
[0041] Next, drawing 6 shows the rough configuration of the minute passage element as 4th operation gestalt.

[0042] Moreover, the upper surface of the minute passage element 40 of this operation gestalt is shown in drawing 7 (a), and the A-A cross section of this drawing (a) is shown in drawing 7

(b). However, let th inferior surface of tongue of the minute passage el ment 40 be a thing equivalent to th configuration of the upper surface of drawing 6 . Here, the same referenc mark is given to th part equival nt to the configuration part shown in th configuration part and drawing 5 of this operation gestalt.
[0043] This minute passage element 40 is the configuration which the polish recon thin film 31 and the polish recon thin film 41 were formed in both sides of the minut passage element 20 mentioned above, and formed two or more apertures 42 in the symmetrical location of the polish recon thin films 31 and 41 which are the direction of the fluid passage 7, and the direction which intersects perpendicularly, and face across this fluid passage 7.
[0044] These apertures 42a-42f and -- carry out incidence of the light from one field, and in order to function as an aperture for observation which detects the transmitted light from the field of another side, even if it does not condense especially detection light, they become detectable [the material which passes through the specific part of passage] in the case of optical analysis. Analysis of minute area is attained by making especially the aperture 42 minute.

[0045] Next, with reference to the formation production process of drawing 8 (a) - (e), formation of said minute passage element 40 is explained.
[0046] First, as shown in drawing 8 (a), the configuration of this operation gestalt is the element substrate which formed at the formation production process of the 2nd operation gestalt shown in drawing 4 mentioned above, and the same formation production process, and silicon oxide 21 was made to intervene between the passage configuration substrate 10 shown by drawing 3 (e), and the passage configuration substrate 13, and was joined using the anode plate conjugation m thod.
[0047] Next, as shown in drawing 8 (b), the spin coat of the photoresist is carried out on each surface of the polish recon thin films 4 and 6 which have covered both sides of the element substrate joined in this drawing (a), and the resist thin film 8 is formed.
[0048] And as shown in drawing 8 (c), patterning is carried out to the configuration of an aperture 42 where the resist thin film 8 is shown in drawing 6 , using photolithography technology, and resist mask 8a is formed. As shown in drawing 8 (d), a part for the outcrop of the polish recon thin films 4 and 6 is removed using RIE by using resist mask 8a as a mask, and the polish recon thin films 4 and 6 which have an aperture 42 are formed.
[0049] Furthermore, as shown in drawing 8 (e), by the plasma asher, resist mask 8a is removed and the minute passage element 40 which has three apertures 42 to both sides, respectively is formed. Here, although the polish recon thin film of element both sides was illustrated in the condition of having been connected with the polish recon thin film of a substrate plane of composition, as shown in drawing 7 (b), the double-sided polish recon thin film 31 and the polish recon thin films 4 and 6 of a plane of composition may be separated on the side.
[0050]

Drawing selection Representative drawing



[Translation done.]

JAPANESE [JP,10-288580,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS DESCRIPTION OF DRAWINGS DRAWINGS CORRECTION OR AMENDMENT

[Translation done.]

.* NOTICES *

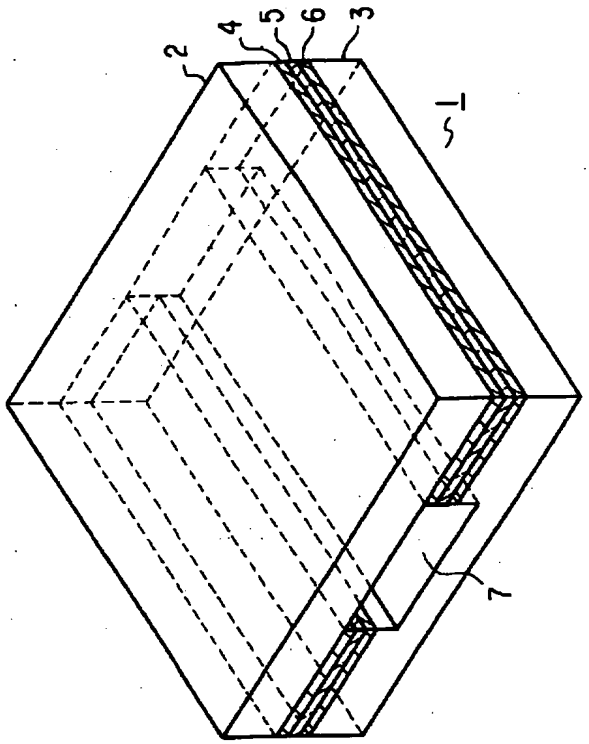
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the rough configuration of the minute passage element as 1st operation gestalt by this invention.
[Drawing 2] Drawing 2 (a) - (h) is drawing for explaining the formation production process of a minute passage element.
[Drawing 3] Drawing 3 (a) - (f) is drawing for explaining the formation production process of the minute passage element following drawing 2 .
[Drawing 4] It is drawing showing the rough configuration of the minute passage element as 2nd operation gestalt.
[Drawing 5] It is drawing showing the rough configuration of the minute passage element as 3rd operation gestalt.
[Drawing 6] It is drawing showing the rough configuration of the minute passage element as 4th operation gestalt.
[Drawing 7] Drawing showing the configuration which saw the minute passage element which showed drawing 7 (a) to drawing 6 from the upper surface, and drawing 7 (b) are drawings showing the structure of the cross section of the A-A line of drawing 7 (a).
[Drawing 8] Drawing 8 (a) - (e) is drawing for explaining the formation production process of the minute passage element shown in drawing 6 .
[Drawing 9] It is drawing showing the rough configuration of the minute passage element as 5th operation gestalt.
[Drawing 10] Drawing showing the configuration which saw the minute passage element which showed drawing 10 (a) to drawing 9 from the upper surface, and drawing 10 (b) are drawings showing the structure of the cross section of the A-A line shown in drawing 10 (a).
[Drawing 11] It is drawing showing the rough configuration of the minute passage element as 6th operation gestalt.
[Drawing 12] Drawing showing the rough configuration of the minute passage element as 7th operation gestalt,
[Drawing 13] Drawing showing the configuration which saw the minute passage element which showed drawing 13 (a) to drawing 12 from the upper surface, and drawing 13 (b) are drawings showing the structure of the cross section of the A-A line shown in drawing 13 (a).
[Description of Notations]
1 -- Minute passage element
2 3 -- Quartz-glass substrate
4 6 -- Polish recon thin film
5 -- Borosilicate glass thin film
7 -- Fluid passage
8 -- Resist thin film
9 -- Slot

8a -- Resist mask

[Translation done.]

Drawing selection R presentativ drawing



[Translation done.]

JAPANESE [JP,10-288580,A]

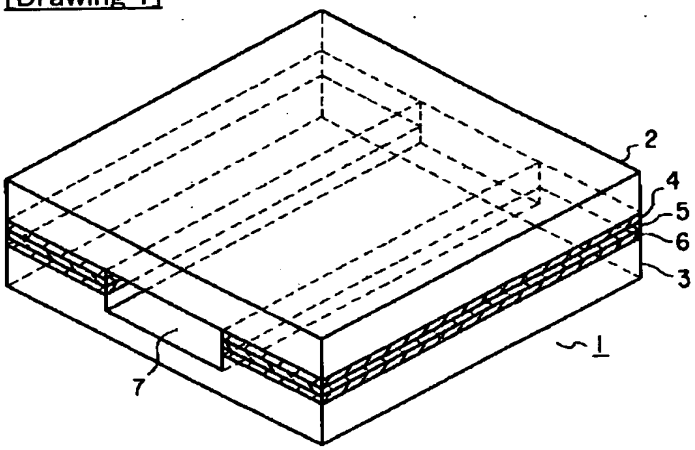
CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS DESCRIPTION OF DRAWINGS DRAWINGS CORRECTION OR AMENDMENT

[Translation done.]

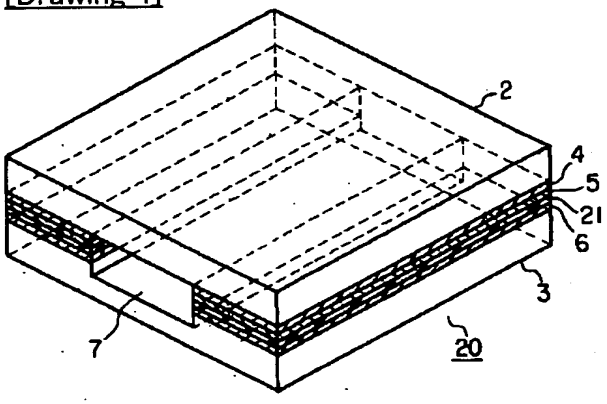
* NOTICES *

DRAWINGS

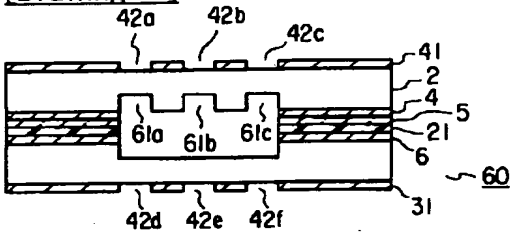
[Drawing 1]



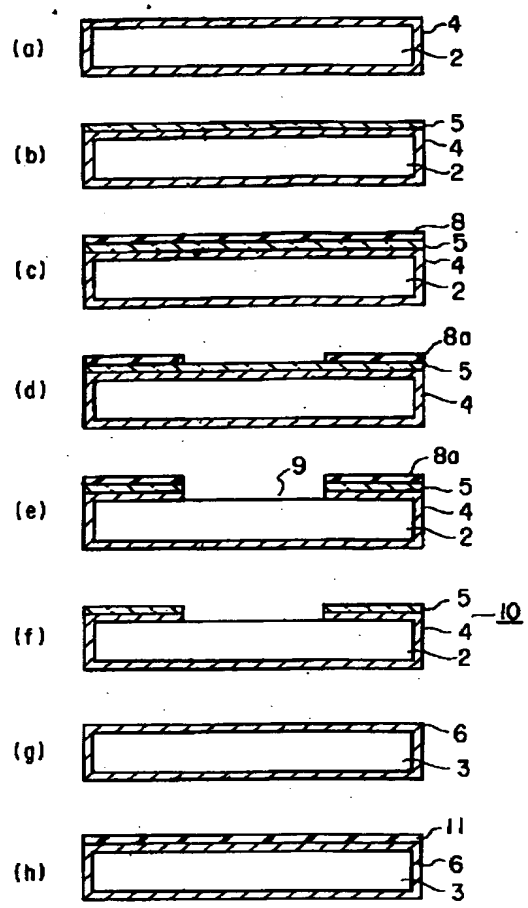
[Drawing 4]



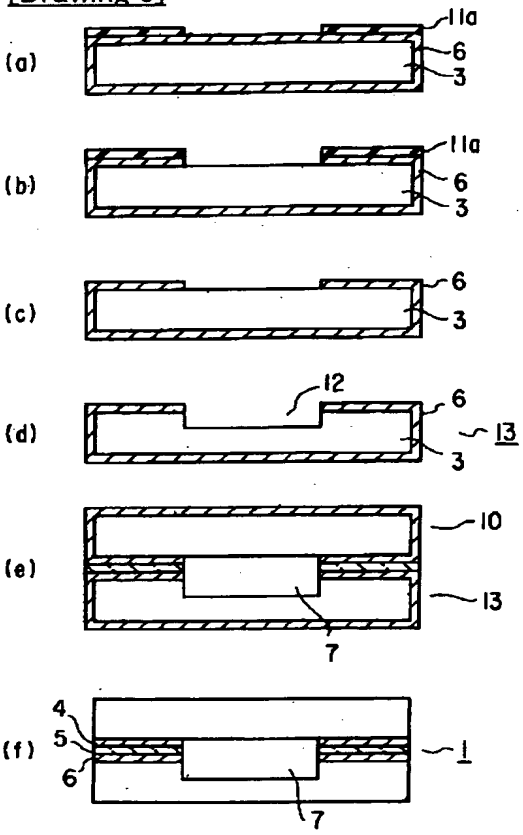
[Drawing 11]



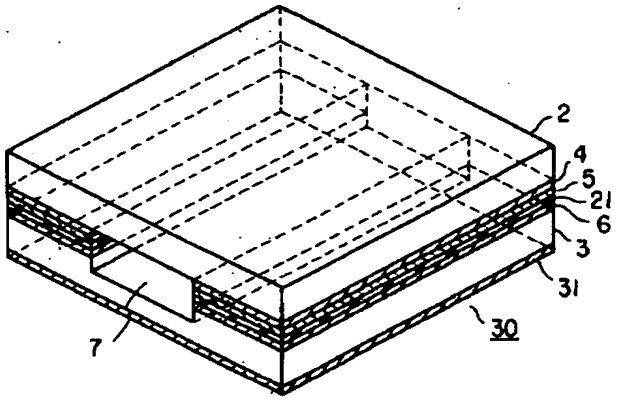
[Drawing 2]



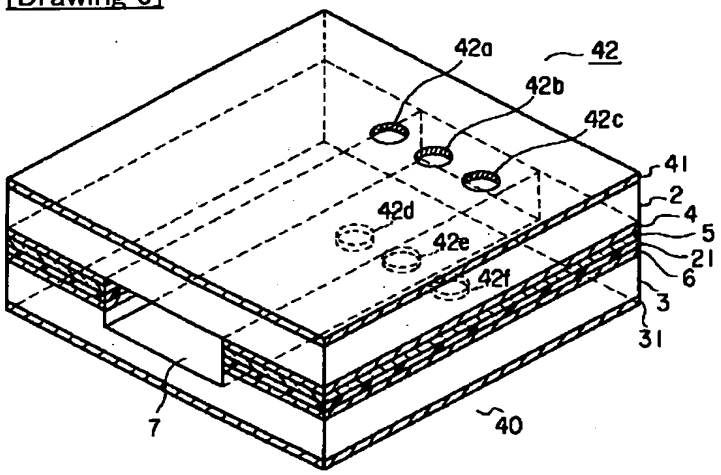
[Drawing 3]



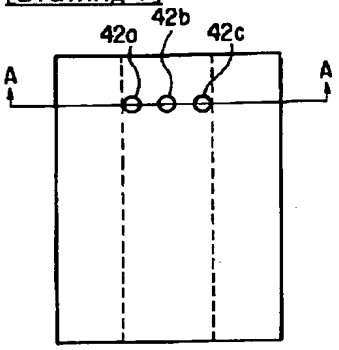
[Drawing 5]



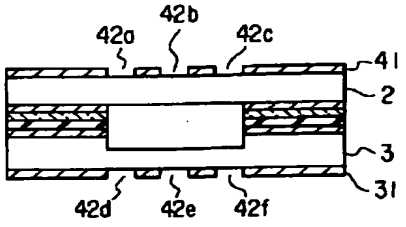
[Drawing 6]



[Drawing 7]

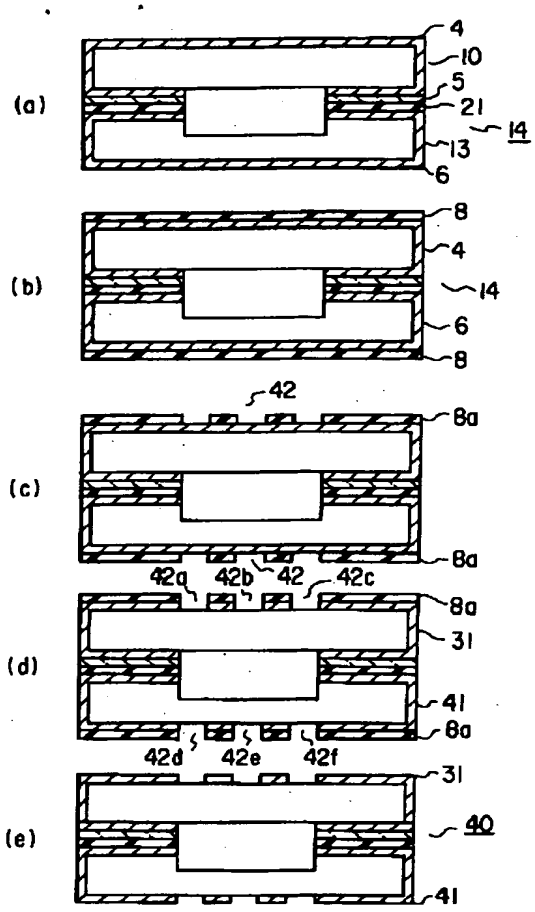


(a)

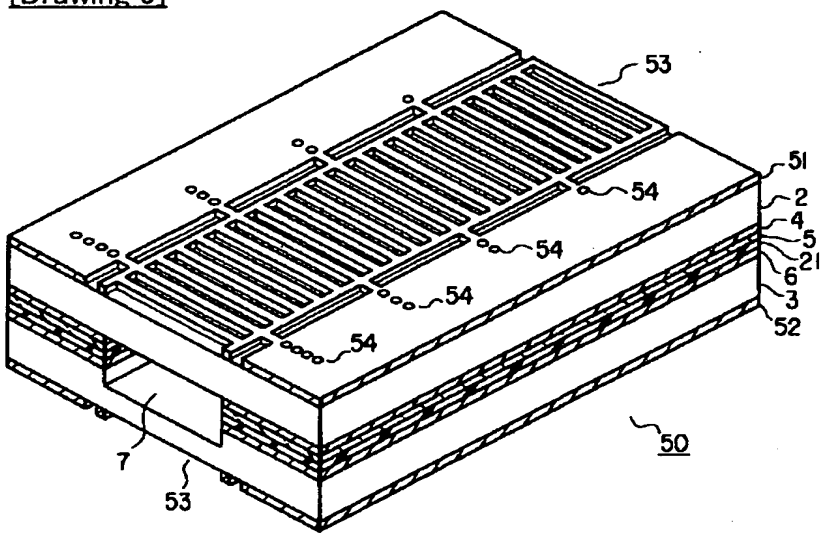


(b)

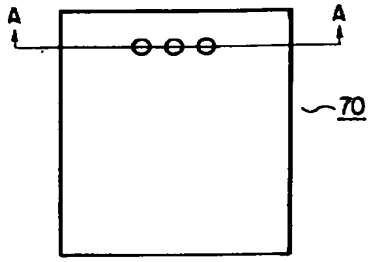
[Drawing 8]



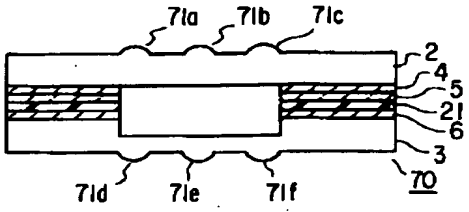
[Drawing 9]



[Drawing 13]

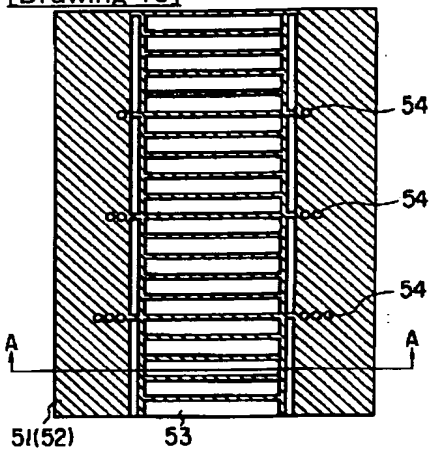


(a)

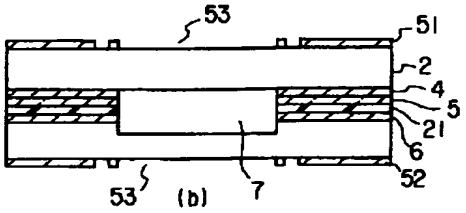


(b)

[Drawing 10]

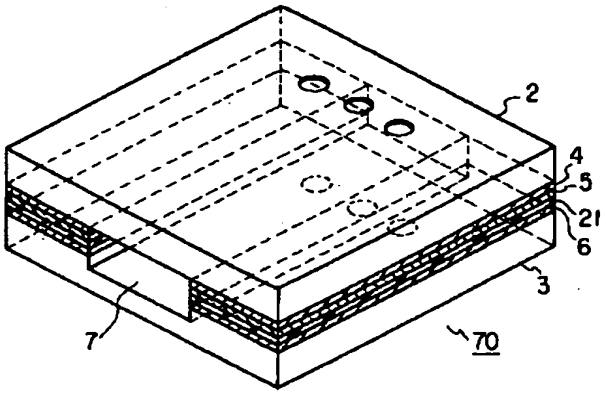


(a)



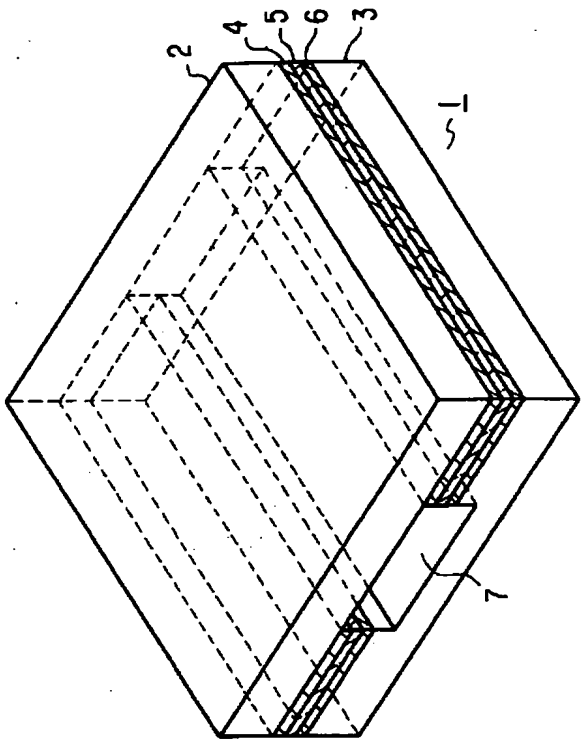
(b)

[Drawing 12]



[Translation done.]

Drawing selection R pres ntative drawing



[Translation done.]

Back to original [JP,10-288580,A]

[Translation don .]

1. Amendment June 26, Heisei 14 (2002)

[Translation done.]

CORRECTION OR AMENDMENT

[Official Gazette Type] Printing of amendment by the convention of 2 of Article 17 of patent law

[Section partition] The 1st partition of the 6th section
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[Year copy format] Open patent official report 10-2886
[Filing Number] Japanese Patent Application No. 9-95864
[The 7th edition of International Patent Classification]

G01N 21/05
H01L 49/00

[FI]

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H01L 49/00

[Procedure revision]
[Filing Date] March 19, Heisei 14 (2002. 3.19)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim
[Method of Amendment] Modification
[Proposed Amendment]
[Claim(s)]
[Claim 1] A quartz-glass substrate of a pair with which a slot where a side [it counters] forms passage in a field on the other hand at least is prepared,
A silicon layer of a pair formed on a field which confronts each other except for a field which touches said slot inside in respect of a side which a quartz-glass substrate of said pair counters,
An alkali ion content glass layer which intervenes between silicon layers of said pair and is formed in contact with both silicon layer,
A minute passage element characterized by providing and being joined in one.
[Claim 2] A quartz-glass substrate of a pair with which a slot where a side [it counters] forms passage in a field on the other hand at least is prepared,

A silicon layer of a pair formed on a field which confronts each other xcept for a field which touches said slot insid in respect of a side which a quartz-glass substrat of said pair counters,
An alkali ion content glass layer which intervenes between silicon layers of said pair and is formed in contact with on silicon layer,
A minute passag l ment characterized by intervening between silicon layers of said pair, providing silicon oxide formed in contact with a silicon layer of another side, and said alkali ion content glass layer, and being joined in one.
[Claim 3] Claim 1 characterized by preparing either a light reflex layer or a light absorption layer in one field by the side of a non-plane of composition of a quartz-glass substrate of said minute passage element, or a minute passage element according to claim 2.
[Procedure amendment 2]
[Document to be Amended] Specification
[Item(s) to be Amended] 0013
[Method of Amendment] Modification
[Proposed Amendment]
[0013]
[Means for Solving the Problem] This invention is the near field where a quartz-glass substrate of a pair with which a slot where a side [it counters] forms passage in a field on the other hand at least is prepared, and a quartz-glass substrate of said pair counter, in order to attain the above-mentioned purpose. Except for a field which touches said slot inside, it intervenes between a silicon layer of a pair formed on a field which confronts each other, and a silicon layer of said pair, and it has an alkali ion content glass layer formed in contact with both silicon layer, and a minute passage element joined in one is offered.
[Procedure amendment 3]
[Document to be Amended] Specification
[Item(s) to be Amended] 0014
[Method of Amendment] Modification
[Proposed Amendment]
[0014] Furthermore, this minute passage element equips with either a light reflex layer or a light absorption layer one [at least] field by the side of the non-plane of composition of the quartz-glass substrate joined face to face.

[Translation done.]

a.

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特開平10－288580

(43)公開日　平成10年(1998)10月27日

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Ｈ０１Ｌ　49/00		Ｈ０１Ｌ　49/00

審査請求　未請求　請求項の数３　ＯＬ　（全 10 頁）

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(22)出願日　平成９年(1997)４月14日

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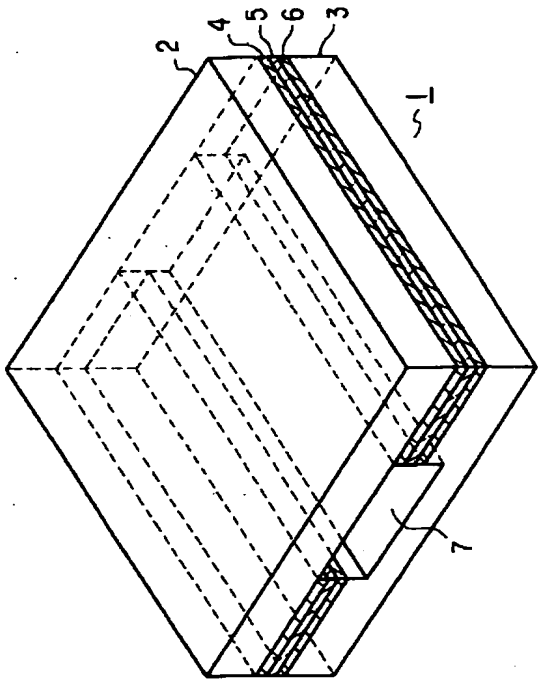
(74)代理人　弁理士　鈴江　武彦　（外４名）

(54)【発明の名称】　微小流路素子

(57)【要約】

【課題】従来技術は、共に、機器分析用流体流路を構成する基板として、ホウケイ酸ガラスを用いているため、紫外波長域の光を吸収してしまい、短波長域での光学検出が出来ないという問題点があった。

【解決手段】本発明の微小流路素子１は、平坦な石英ガラス基板２と、少なくとも一方の面に溝が形成された石英ガラス基板３とが、ポリシリコン薄膜４、アルカリイオン含有ガラス層例えば、ホウケイ酸ガラス薄膜５、ポリシリコン薄膜６からなる積層膜を介在させて接合して構成する。そのため、石英ガラス基板２と溝９が形成された石英ガラス基板３とによって囲まれた空間によって、機器分析用流体流路７が形成されており、紫外から可視の波長域の光の透過性に優れた石英ガラス基板に流体流路が形成されており、紫外から可視の波長域において、光学的検出が可能になる。



【特許請求の範囲】
【請求項１】　対向する側の少なくとも一方面に流路を形成する溝が設けられる一対の石英ガラス基板と、
前記一対の石英ガラス基板の対向する側の面で、前記溝内面及び該溝の開口に接する面を除き、対峙する面上に形成される一対のシリコン層と、
前記一対のシリコン層間に介在し、両シリコン層に接して形成されるアルカリイオン含有ガラス層と、を具備し、一体的に接合されることを特徴とする微小流路素子。
【請求項２】　対向する側の少なくとも一方面に流路を形成する溝が設けられる一対の石英ガラス基板と、
前記一対の石英ガラス基板の対向する側の面で、前記溝内面及び該溝の開口に接する面を除き対峙する面上に形成される一対のシリコン層と、
前記一対のシリコン層間に介在して、一方のシリコン層に接して形成されるアルカリイオン含有ガラス層と、
前記一対のシリコン層間に介在して、他方のシリコン層及び前記アルカリイオン含有ガラス層とに接して形成されるシリコン酸化膜と、を具備し、一体的に接合されることを特徴とする微小流路素子。
【請求項３】　前記微小流路素子の石英ガラス基板の非接合面側の少なくとも一方の外面に反射膜を設けたことを特徴とする請求項１若しくは、請求項２に記載の微小流路素子。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、ガラス基板を用いた機器分析用流体流路に関する。
【０００２】
【従来の技術】一般に、機器分析用流体流路は、ガラスやステンレス等の細管を用いて構成されている。
【０００３】この細管は、分析能力を向上させるために、通常５０cm程度の長さで利用されるが、この細管を円状に丸めて使用しているため小型化が困難であった。
【０００４】従来、小型化する手段としては、半導体製造技術を用いて、シリコン基板等に微細な溝を形成する技術が報告されている。しかし、高電圧を印加して分離を行うキャピラリー電気泳動に用いようとすると、半導体からなるシリコン基板では電流がリークするため、高電圧が印加できないという問題点があった。
【０００５】そこで電流のリークが生じない機器分析用流体流路としては、絶縁体のガラス基板に微細な溝を加工して、流路を形成する方法が知られている。
【０００６】例えば、「Micromachining of Capillary Electrophoresis Injectors and Separators on Glass Chips and Evaluation of Flow at Capillary Intersections」（Anal. Chem. 1994, 66, P177-184）には、ホウケイ酸ガラス基板に溝加工を施した後、該ホウケイ酸ガラス基板を加熱によって溶着して形成した流路について、掲載されている。
【０００７】この溝加工は、ホウケイ酸ガラス基板に金属蒸着膜を成膜し、フォトリソグラフィ技術によって、金属膜をパターニングした後、この金属膜をマスクとして用いて、フッ酸を混合した溶液にホウケイ酸ガラス基板を浸漬させ、エッチングしてU溝を形成する。さらに、U溝を塞ぐように、溝加工したホウケイ酸ガラス基板に平坦なホウケイ酸ガラス基板を重ね合わせ、７００℃まで加熱して溶着している。
【０００８】また他に、「A New Fbrication Method of Borosilicate Glass Capillary Tubes with Lateral Inlets and Outlets」（Analytical Methods &; Instrumentation, Special Issue μTAS '96 p214）には、ホウケイ酸ガラス基板に溝を形成し、このホウケイ酸ガラス基板と他の平坦なホウケイ酸ガラス基板を陽極接合法にて接合して流路を形成する技術が記載されている。
【０００９】この技術によれば、溝加工は、ホウケイ酸ガラス基板に低圧化学的気相成長（ＬＰＣＶＤ）によって、ポリシリコン（poly-Si）薄膜を成膜させ、フォトリソグラフィ技術を用いて、ポリシリコン薄膜をパターニングした後、該ポリシリコン薄膜をマスクとして、フッ酸を混合した溶液にホウケイ酸ガラス基板を浸漬させ、エッチングして溝を形成する。
【００１０】そして、陽極接合は、一方のホウケイ酸ガラス基板上のポリシリコン薄膜と他方のホウケイ酸ガラス基板との間に電圧を印加させながら、加熱によって接合している。
【００１１】
【発明が解決しようとする課題】従来、機器分析用流体流路を用いて液体を分離分析する場合、分離物質の検出は、光学的検出が一般的な手法である。前述した従来技術は、共に、機器分析用流体流路を構成する基板として、ホウケイ酸ガラスを用いているため、紫外波長域の光を吸収してしまい、短波長域での光学検出が出来ないという問題点があった。
【００１２】そこで本発明は、紫外から可視の波長域に渡って、光学的検出が可能であり、且つ容易に小型化が可能な機器分析用流体流路を有する微小流路素子を提供することを目的とする。
【００１３】
【課題を解決するための手段】本発明は上記目的を達成するために、対向する側の少なくとも一方面に流路を形成する溝が設けられる一対の石英ガラス基板と、前記一対の石英ガラス基板の対向する側の面で、前記溝内面及び該溝の開口に接する面を除き対峙する面上に形成される一対のシリコン層と、前記一対のシリコン層間に介在して、両シリコン層に接して形成されるアルカリイオン含有ガラス層とを備え、一体的に接合される微小流路素子を提供する。
【００１４】さらにこの微小流路素子は、対向して接合

する石英ガラス基板の非接合面側の少なくとも一方面で前記流路に掛かる位置に複数の開口部を有する、光反射層若しくは光吸収層のいずれか一方を備える。

【００１５】以上のような構成の微小流路素子は、紫外から可視の波長域の光の透過性に優れた石英ガラス基板に溝（流体流路）が形成されており、紫外から可視の波長域において、光学的検出が可能になる。また、半導体製造技術を用いて、微細な流体流路を石英ガラス基板上に形成するため、微小流路素子が小型化される。

【００１６】

【発明の実施の形態】以下、図面を参照して本発明の実施形態について詳細に説明する。

【００１７】図１には、本発明による第１の実施形態としての微小流路素子の概略的な構成を示し説明する。

【００１８】この微小流路素子１は、平坦な石英ガラス基板２と、少なくとも一方の面に溝が形成された石英ガラス基板３とが、ポリシリコン薄膜４、アルカリイオン含有ガラス層例えば、ホウケイ酸ガラス薄膜５、ポリシリコン薄膜６からなる積層膜を介在させて接合して構成されている。この石英基板２と溝が形成された石英ガラス基板３とによって囲まれた空間によって、機器分析用流体流路（以下、流体流路と称する）７が形成されている。

【００１９】次に、図２（ａ）～（ｈ）及び図３（ａ）～（ｆ）を参照して、微小流路素子の形成工程について説明する。

【００２０】まず、図２（ａ）に示すように、石英ガラス基板２の全表面上に、ＬＰＣＶＤを用いて、ノンドープのポリシリコン薄膜４を成膜する。本実施形態において、石英ガラス基板２の厚さは、１㎜以下の両面研磨した石英基板が望ましく、また、ポリシリコン薄膜４の膜厚は、１μｍ以下であることが望ましい。

【００２１】次に、図２（ｂ）に示すように、前記ポリシリコン薄膜４の一方の表面上に、スパッタリングによって、ホウケイ酸ガラス薄膜５を成膜する。このホウケイ酸ガラス薄膜５の膜厚は、１μｍ以下であることが望ましい。さらに図２（ｃ）に示すように、ホウケイ酸ガラス薄膜５の表面に、ポジ型フォトレジストをスピンコートし、レジスト膜８を成膜する。

【００２２】図２（ｄ）に示すように、フォトリソグラフィ技術によって、レジスト膜８をパターニングして、レジストマスク８ａを形成する。図２（ｅ）に示すように、異方性エッチング、例えば、リアクティブイオンエッチング（ＲＩＥ）によって、レジストマスク８ａに覆われた以外の領域で露出するホウケイ酸ガラス薄膜５を除去し、さらに下層のポリシリコン薄膜４を除去した後、図２（ｆ）に示すように、プラズマアッシャによって、レジストマスク８ａを除去し、溝９を有する流路構成基板１０を形成する。

【００２３】次に、図２（ｇ）に示すように、別の石英ガラス基板３の全表面上に、ＬＰＣＶＤによって、ノンドープのポリシリコン薄膜６を成膜する。この石英ガラス基板３は、厚さ１㎜以下の両面研磨した石英基板が望ましく、成膜するポリシリコン薄膜６の膜厚は、１μｍ以下であることが望ましい。

【００２４】次に、図２（ｈ）に示すように、ポリシリコン薄膜６の表面にポジ型フォトレジストをスピンコートし、レジスト薄膜１１を成膜した後、図３（ａ）に示すように、フォトリソグラフィ技術によってレジストマスク１１ａをパターニングする。

【００２５】そして図３（ｂ）に示すように、レジストマスク１１ａをマスクとして、ＲＩＥによって、露出するポリシリコン薄膜６を除去した後、図３（ｃ）に示すように、プラズマアッシャによって、レジストマスク１１ａを除去する。

【００２６】次に図３（ｄ）に示すように、フッ酸とフッ化アンモニウムを混合した溶液に石英ガラス基板３を浸漬し、パターニングしたポリシリコン薄膜６をマスクとして用いて、石英ガラス基板３の露出した部分をウェットエッチングにより除去し、溝１２を有する流路構成基板１３を形成する。この溝１２は、溝の深さまたは幅が１００μｍ以下であることが望ましい。

【００２７】さらに、図３（ｅ）に示すように、前記流路構成基板１０及び流路構成基板１３の溝部分が合致するように重ね、陽極接合法を用いて接合して、素子基板１４を形成する。

【００２８】この陽極接合は、ポリシリコン薄膜４とポリシリコン薄膜６との間に電圧を印加しつつ、基板全体を加熱して行う。この時の加熱温度は、３５０～５００℃程度、印加電圧は２００～１０００（Ｖ）が望ましい。

【００２９】次に、図３（ｆ）に示すように、同図（ｅ）に示す接合された素子基板１４の表面のポリシリコン薄膜をＲＩＥまたはウェットエッチングによって除去し、微小流路素子１を構成する。

【００３０】本実施形態では、ポリシリコン薄膜からなるシリコン層を用いたが、アモルファスシリコン薄膜であってもよく、また、該シリコン薄膜はノンドープシリコン薄膜が望ましい。シリコン薄膜の成膜は、ＬＰＣＶＤだけでなく、プラズマＣＶＤ、スパッタリング、ＥＣＲ、蒸着等の半導体成膜技術を応用して形成することが出来る。また、前記溝は、直線形状であるが、それに限定されず、曲線形状であっても、波形状であってもよい。また、溝の深さまたは幅は、１５０μｍ以下であることが望ましく、溝加工には、半導体技術を用いたウエット及びドライエッチングや機械的な加工などを用いることが出来る。

【００３１】本実施形態では、アルカリイオン含有ガラス層として、ホウケイ酸ガラス薄膜を用いたが、この他に、ソーダガラス薄膜などであってもよい。

【００３２】このように構成された微小流路素子１は、紫外から可視の波長域の光の透過性に優れた石英ガラス基板に溝（流体流路）が形成されているため、紫外から可視の波長域において、光学的検出が可能になる。この微小流路素子１は、主としてガラスより構成されており、シリコン薄膜は、ノンドープシリコン薄膜で、且つ膜厚が１μｍ以下のであるため、キャピラリー電気泳動用流路として高電圧印加した場合においても、電気泳動に影響を与えるような電流のリークが生じない。また、本実施形態では、半導体プロセス技術を応用しているため、微細な溝流路の形成が容易になり、微小流路素子の小型化が実現できる。

【００３３】次に図４には、第２の実施形態としての微小流路素子の概略的な構成を示し説明する。ここで、図１に示した構成部位と本実施形態の構成部位と同等の部位には、同じ参照符号を付している。

【００３４】この微小流路素子２０は、平坦な石英ガラス基板２と、少なくとも一方の面に溝が形成された石英ガラス基板３とが、ポリシリコン薄膜４、アルカリイオン含有ガラス層例えば、ホウケイ酸ガラス薄膜５、シリコン酸化膜（SiO_2）２１、ポリシリコン薄膜６からなる積層膜を介在させて接合して構成されている。この石英ガラス基板２と溝が形成された石英ガラス基板３とによって囲まれた空間によって、流体流路７が形成されている。

【００３５】この微小流路素子２０は、前述した図２（ｂ）工程と（ｃ）工程との間で、ホウケイ酸ガラス薄膜５の表面上に、スパッタリングによってシリコン酸化膜２１を成膜する工程を加えることによって作成する。この時、シリコン酸化膜２１の膜厚は、５００μｍ以下が望ましい。

【００３６】このような微小流路素子２０は、ホウケイ酸ガラス薄膜５とポリシリコン薄膜６との間に絶縁体であるシリコン酸化膜２１を介在させているため、前述した第１の実施形態における微小流路素子１の効果に加え、陽極接合の際に、絶縁破壊による電流リークを防ぐため、接合が容易となる。また、同時にポリシリコン薄膜４とポリシリコン薄膜６との間に、高電圧が印加し安くなるため、ホウケイ酸ガラス薄膜５の膜厚が薄くとも接合が容易となる。

【００３７】次に図５は、第３の実施形態としての微小流路素子の概略的な構成を示す。

【００３８】この微小流路素子３０は、第２の実施形態の微小流路素子２０の一方の面にポリシリコン薄膜３１を形成した構成例である。この微小流路素子３０は、前述した図３（ｅ）工程において、一方の面のポリシリコン薄膜４若しくはポリシリコン薄膜６を除去し、他方面のポリシリコン薄膜を除去せずに残しておくことで形成することができる。図５においては、ポリシリコン薄膜６（３１）を残している例を示している。

【００３９】このように構成された微小流路素子３０は、一方の面にポリシリコン薄膜３１を形成しているため、前述した微小流路素子１及び微小流路素子２０の作用・効果に加えて、微小流路素子の上側の石英ガラス基板２の側に、発光素子と受光素子を設けて、石英ガラス基板２の側から検出光を入射し、その反射光を検出して分析する際、光の反射率が高くなり検出感度が向上する。

【００４０】なお、本実施形態においては、例えば、ポリシリコン薄膜３１は、光の反射膜として他の部材を用いることができ、例えば、アルミニウムなどの金属薄膜を用いてもよい。

【００４１】次に図６は、第４の実施形態としての微小流路素子の概略的な構成を示す。

【００４２】また、図７（ａ）には、本実施形態の微小流路素子４０の上面を示し、図７（ｂ）には、同図（ａ）のＡ－Ａ断面を示す。但し、微小流路素子４０の下面は、図６の上面の形状と同等であるものとする。ここで、本実施形態の構成部位と図５に示した構成部位と同等の部位には、同じ参照符号を付している。

【００４３】この微小流路素子４０は、前述した微小流路素子２０の両面に、ポリシリコン薄膜３１およびポリシリコン薄膜４１が形成され、流体流路７の方向と直交する方向で、該流体流路７を挟むポリシリコン薄膜３１，４１の対称的位置に複数の窓４２を形成した構成である。

【００４４】これらの窓４２ａ，～，４２ｆ，…は、一方の面から光を入射し、他方の面から透過光を検出する観測用窓として機能するため、光学的分析の際、特に検出光を集光しなくとも流路の特定の部位を通過する物質の検出が可能となる。特に窓４２を微小にすることにより、微小エリアの分析が可能となる。

【００４５】次に図８（ａ）～（ｅ）の形成工程を参照して、前記微小流路素子４０の形成について説明する。

【００４６】まず、図８（ａ）に示すように、本実施形態の構成は、前述した図４に示した第２の実施形態の形成工程と同様な形成工程で形成し、図３（ｅ）で示した流路構成基板１０と流路構成基板１３の間にシリコン酸化膜２１を介在させて、陽極接合法を用いて接合した素子基板である。

【００４７】次に、図８（ｂ）に示すように、同図（ａ）で接合した素子基板の両面を覆っているポリシリコン薄膜４、６のそれぞれの表面上にフォトレジストをスピンコートして、レジスト薄膜８を成膜する。

【００４８】そして図８（ｃ）に示すように、フォトリソグラフィ技術を用いて、レジスト薄膜８を図６に示すような窓４２の形状にパターニングして、レジストマスク８ａを形成する。図８（ｄ）に示すように、レジストマスク８ａをマスクとしてＲＩＥを用いて、ポリシリコン薄膜４、６の露出部分を除去し、窓４２を有するポリ

シリコン薄膜４、６を形成する。

【００４９】さらに、図８（ｅ）に示すように、プラズマアッシャによって、レジストマスク８ａを除去し、それぞれ両面に３つの窓４２を有する微小流路素子４０を形成する。ここで、素子両面のポリシリコン薄膜を基板接合面のポリシリコン薄膜と繋がった状態で図示したが、図７（ｂ）に示すように、両面のポリシリコン薄膜３１と接合面のポリシリコン薄膜４、６とは側面にて分離されていてもよい。

【００５０】本実施形態の微小流路素子４０は、前述した微小流路素子１、２０の作用・効果に加えて、微小流路素子の両面に流路の特定の部位を通過する物質の検出を可能にする窓４２を有している。

【００５１】なお、本実施形態の各構成は、各種変形、変更が可能である。例えば、ポリシリコン薄膜３１、４１は、光の透過率の低い他の膜に変更することが可能であり、例えば、スパッタリングや蒸着やメッキなどによって形成したアルミニウム等の金属薄膜を用いてもよい。

【００５２】また、窓４２は素子の両面に設けたが、光学検出の際、光の反射を利用する場合はどちらか片方の面に設けてもよい。

【００５３】次に図９には、第５の実施形態として、泳動観察窓を有する微小流路素子の概略的な構成を示し説明する。図１０（ａ）には、この微小流路素子の上面を示し、図１０（ｂ）は、同図（ａ）に示すＡ－Ａ線の断面を示す。また、本実施形態の微小流路素子の下面の構成は、上面の構成と同等である。

【００５４】この微小流路素子５０は、第２の実施形態の微小流路素子２０の両面にポリシリコン薄膜５１、５２を形成し、流体流路７の方向と直交する方向の長方形で、該流体流路７を挟むポリシリコン薄膜５１、５２の対称的な位置に、流体流路７の方向に沿って一定間隔を開けて、ラダー状に配置された複数の窓５３を形成し、さらに、これらの窓５３を一定の数毎に区切る目盛５４を形成して構成する。この微小流路素子５０は、図８に示した微小流路素子４０の形成工程と同じ形成工程で、素子基板両面に形成するレジストマスクのパターン形状を変えることにより構成できる。

【００５５】このような微小流路素子５０は、微小流路素子１及び２０の作用・効果に加えて、素子基板の両面に流体流路に沿って、一定間隔を開けて配置された複数の窓５３及び目盛５４は、泳動状況を観測する定規として働き、分析対象物の泳動状況の追跡が容易となる。

【００５６】なお、本実施形態の各構成は、当然、各種変形、変更が可能である。例えば、ポリシリコン薄膜５１及び５２は、例えばスパッタリングや蒸着やメッキ等によって形成されたアルミニウム等の金属薄膜でもよく、光の透過率の低い他の膜に変更することができる。また、これらの窓５３は、素子基板の両面に設けたが、光学検出の際、光の反射を利用する場合は、どちらか片方の面に設けて構成してもよい。

【００５７】次に、第６の実施形態として、光路長を延長した微小流路素子について図１１により説明する。

【００５８】図１１は、この実施形態の概略的な構成を示す断面図であり、この微小流路素子６０の基本的な構成は、図６及び図７に示した第４の実施形態の微小流路素子４０の構成とほぼ同様であり、前記第４の実施形態とは、石英ガラス基板２の内側に複数の窪みを形成した点が異なる実施形態となっている。なお、微小流路素子６０の上面（ポリシリコン薄膜４１）側及び下面（ポリシリコン薄膜３１）側の構成についても、第４の実施形態と同様に、上面側、下面側ともに、それぞれ３つの窓４２ａ～４２ｃ（上面側）、４２ｄ～４２ｆ（下面側）を設けた構成となっている。

【００５９】この微小流路素子６０は、微小流路素子４０の流体流路７を構成する一方の石英ガラス基板の内側に、複数の窪み６１ａ、６１ｂ、６１ｃを形成する。これらの窪み６１ａ、６１ｂ、６１ｃは、窓４２の内側に構成されている。本実施形態では、３つの窪みを記載しているが、これに限定されるものではない。

【００６０】このように構成された微小流路素子６０は、前述した微小流路素子１、２０及び４０の作用・効果に加えて、流体流路７の光学検出用窓４２の内側に複数の窪みを形成しているため、検出部の光路長が長くなり検出感度が向上する。

【００６１】なお、本実施形態の各構成は、当然、各種変形、変更が可能である。例えば、これらの窪み６１ａ、６１ｂ、６１ｃは、流体流路を構成する石英ガラス基板の一方の内側に設けたが、両方の石英ガラス基板の内側に設けることもできる。また、素子基板の両面に設けた窓４２を有するポリシリコン薄膜３１、４１は、共に省略することもできる。

【００６２】次に第７の実施形態として、レンズを備える微小流路素子の概略的な構成について説明する。図１２には、本実施形態の微小流路素子の概略的な構成を示し、図１３（ａ）には、この微小流路素子の上面の構成を示し、図１３（ｂ）には、同図（ａ）に示すＡ－Ａ線の断面構成を示す図である。また、この微小流路素子の下面の構成は、上面の構成と同じである。

【００６３】この微小流路素子７０は、微小流路素子２０を構成する石英ガラス基板２、３の流体流路７上方で、流体流７と直交する方向に配列される、複数の凸レンズ形状の突起部７１ａ～７１ｆを有して構成される。

【００６４】この微小流路素子７０は、前述した微小流路素子１及び２０の構成に加えて、素子基板の両面に凸レンズ形状の突起部７１ａ～７１ｆを複数、形成したものであり、これらの突起部７１ａ～７１ｆは、一方面の突起部から光を入射し、他方面の突起部から透過光を検出すると、入射光を集光する働きがあり検出感度が向上

する。なお、本実施形態では、凸レンズ型の６つの突起部を形成したが、これに限定されるものではなく、同じ機能として作用する範囲で形状の変形やそれらの数の変更が可能である。

【００６５】以上の実施形態について説明したが、本明細書には以下のような発明も含まれている。

【００６６】（１）対向する側の少なくとも一方面に流路を形成する溝が設けられる一対の石英ガラス基板と、前記一対の石英ガラス基板にそれぞれ接して介在し、前記溝を除く領域上に形成される一対のシリコン層と、前記一対のシリコン層間に介在して、両シリコン層に接して形成されるアルカリイオン含有ガラス層とを具備し、一体的に接合されることを特徴とする微小流路素子。

【００６７】本発明は、第１の実施形態に対応する。

【００６８】本発明の微小流路素子は、紫外から可視の波長域の光の透過性に優れた石英ガラス基板により流路が形成されており、紫外から可視の波長域に渡って、光学的検出が可能である。また、微小流路素子は主に石英ガラスより構成されており、シリコン薄膜は、ノンドープシリコン薄膜で且つ１μm 以下の膜厚で形成するため、キャピラリー電気泳動用流路として高電圧印加した場合においても、電気泳動に影響を与えるような電流のリークは生じない。また、前記微小流路素子は、半導体製造技術を利用して、微細な流体流路を有する小型化が可能である。

【００６９】（２）対向する側の少なくとも一方面に流路を形成する溝が設けられる一対の石英ガラス基板と、前記一対の石英ガラス基板にそれぞれ接して介在し、前記溝を除く領域上に形成される一対のシリコン層と、前記一対のシリコン層間に介在して、一方のシリコン層に接して形成されるアルカリイオン含有ガラス層と、前記一対のシリコン層間に介在して、他方のシリコン層及び前記アルカリイオン含有ガラス層とに接して形成されるシリコン酸化膜とを備え、一体的に接合される微小流路素子。

【００７０】少なくとも一方に流路を形成する溝が設けられてある一対の石英基板と、石英基板に接して石英基板間に設けられた一対のシリコン層と、一対のシリコン層間に設けられたアルカリイオン含有ガラス層およびシリコン酸化物層とからなることを特徴とする微小流路素子。

【００７１】本発明は、第２～第７の実施形態に対応する。

【００７２】本発明の微小流路素子は、（１）項の構成による作用・効果に加えて、アルカリイオン含有ガラス薄膜とシリコン薄膜の間に絶縁体であるシリコン酸化膜を介在させているため、陽極接合の際に、絶縁破壊による電流リークを防止し、接合が容易となる。また、同時にポリシリコン薄膜の間の耐圧が上がり高電圧が印加し易くなるため、アルカリイオン含有ガラス薄膜の膜厚が薄くとも接合が容易になる。

【００７３】（３）前記微小流路素子の石英ガラス基板の非接合面側の少なくとも一方の外面に反射膜を設けたことを特徴とする前記（１）項若しくは、（２）項に記載の微小流路素子。

【００７４】本発明は、第３の実施形態に対応する。

【００７５】本発明の微小流路素子は、前記（１）項及び、（２）項の作用・効果に加え、一方の面にシリコン薄膜を有しているため、シリコン薄膜で覆われていない他方の面から検出光を入射しその反射光を検出して分析する際、光の反射率が高くなり検出感度が向上する。

【００７６】（４）前記微小流路素子の石英ガラス基板の非接合面側の少なくとも一方の外面の前記流路に掛かる位置に複数の開口部を有する、光反射層若しくは光吸収層のいずれか一方を具備することを特徴とする前記（１）項若しくは、（２）項に記載の微小流路素子。

【００７７】本発明は、第４の実施形態に対応する。

【００７８】本発明の微小流路素子は、素子の両面にシリコン薄膜を複数パターニングして構成した窓を有している。該窓は一方の面から光を入射し他方の面から透過光を検出する観測窓として働くため、光学的分析の際、特に検出光を集光しなくとも流路の特定の部位を通過する物質の検出が可能となる。特に観察窓を微小にすることにより、微小エリアの分析が可能となる。

【００７９】（５）前記微小流路素子の石英ガラス基板の非接合面側の少なくとも一方の外面の前記流路に掛かる位置で、前記流路の液体が流れる方向に、複数の開口部を前記流路の目盛りとして備える、光反射層若しくは光吸収層のいずれか一方を具備することを特徴とする前記（４）項に記載の微小流路素子。

【００８０】本発明は、第５の実施形態に対応する。

【００８１】本発明の微小流路素子は、素子の一方面または両面に流路に沿って一定間隔を開けて複数パターニングされた窓を有しており、該複数パターンによって流路の目盛が形成されている。該窓は泳動状況を観測する定規として働き、分析対象物の泳動状況の追跡が容易となる。

【００８２】（６）前記光反射層若しくは光吸収層に設けられた開口部の石英ガラス基板の流路内側に、凹部を設けたことを特徴とする（３）項に記載の微小流路素子。

【００８３】本発明は、第６の実施形態に対応する。

【００８４】本発明の微小流路素子は、流路の内側に凹部を有しているため、凹部に検出光を入射し光学検出を行うと、検出部の光路長が長くなり検出感度が向上する。

【００８５】（７）前記微小流路素子の石英ガラス基板の非接合面側の少くなくとも一方面上に、凸形状の突起を備えることを特徴とする前記（１）項若しくは（２）項に記載の微小流路素子。

【００８６】本発明は、第７の実施形態に対応する。

【００８７】本発明の微小流路素子は、素子の両面に凸レンズ形状の突起部を有している。該突起部は一方面の突起部から光を入射し他方面の突起部から透過光を検出すると、入射光を集光する働きがあり検出感度が向上する。

【００８８】

【発明の効果】以上詳述したように本発明によれば、紫外から可視の波長域に渡って、光学的検出が可能であり、且つ容易に小型化が可能な機器分析用流体流路を有する微小流路素子を提供することができる。

【図面の簡単な説明】

【図１】本発明による第１の実施形態としての微小流路素子の概略的な構成を示す図である。

【図２】図２（ａ）～（ｈ）は、微小流路素子の形成工程について説明するための図である。

【図３】図３（ａ）～（ｆ）は、図２に続く微小流路素子の形成工程について説明するための図である。

【図４】第２の実施形態としての微小流路素子の概略的な構成を示す図である。

【図５】第３の実施形態としての微小流路素子の概略的な構成を示す図である。

【図６】第４の実施形態としての微小流路素子の概略的な構成を示す図である。

【図７】図７（ａ）は、図６に示した微小流路素子を上面からみた構成を示す図、図７（ｂ）は、図７（ａ）のＡ－Ａ線の断面の構造を示す図である。

【図８】図８（ａ）～（ｅ）は、図６に示した微小流路素子の形成工程について説明するための図である。

【図９】第５の実施形態としての微小流路素子の概略的な構成を示す図である。

【図１０】図１０（ａ）は、図９に示した微小流路素子を上面からみた構成を示す図、図１０（ｂ）は、図１０（ａ）に示すＡ－Ａ線の断面の構造を示す図である。

【図１１】第６の実施形態としての微小流路素子の概略的な構成を示す図である。

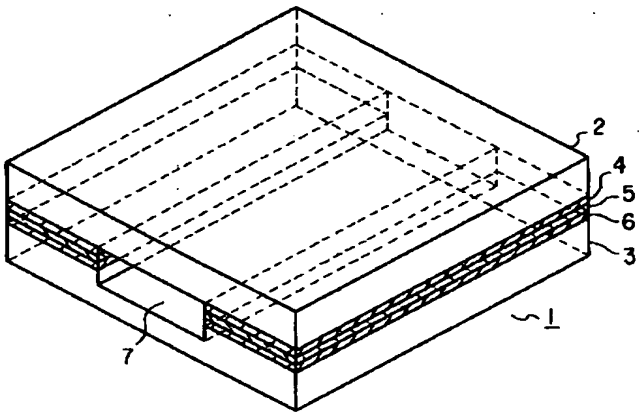
【図１２】第７の実施形態としての微小流路素子の概略的な構成を示す図、

【図１３】図１３（ａ）は、図１２に示した微小流路素子を上面からみた構成を示す図、図１３（ｂ）は、図１３（ａ）に示すＡ－Ａ線の断面の構造を示す図である。

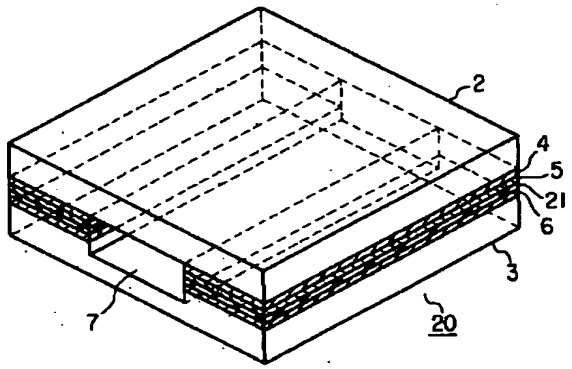
【符号の説明】

１…微小流路素子
２．３…石英ガラス基板
４．６…ポリシリコン薄膜
５…ホウケイ酸ガラス薄膜
７…流体流路
８…レジスト薄膜
９…溝
８ａ…レジストマスク

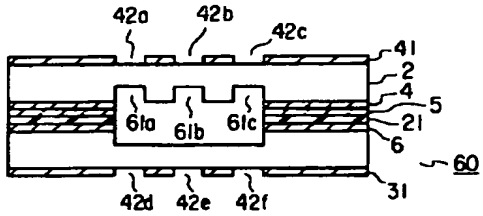
【図１】



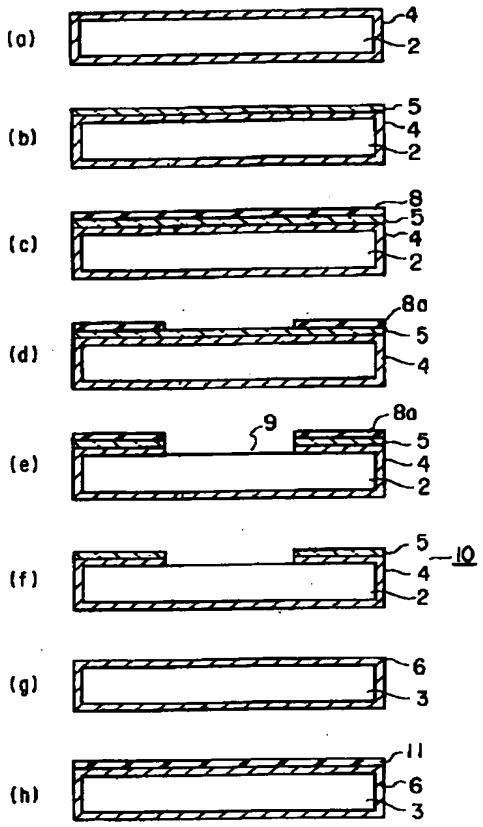
【図４】



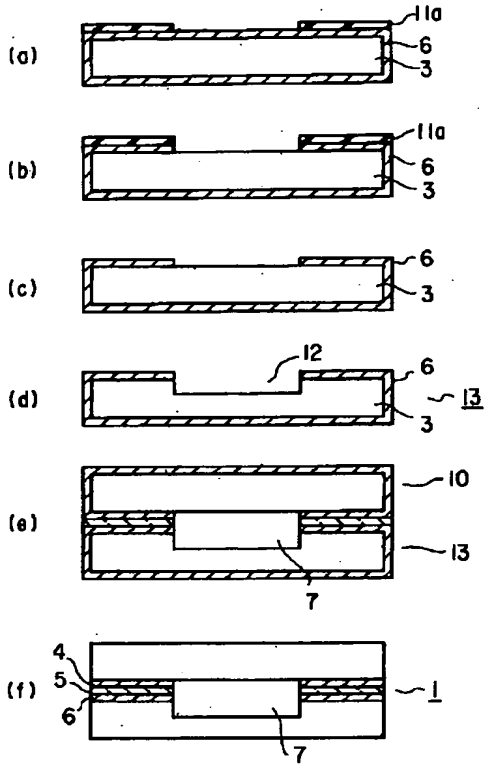
【図１１】



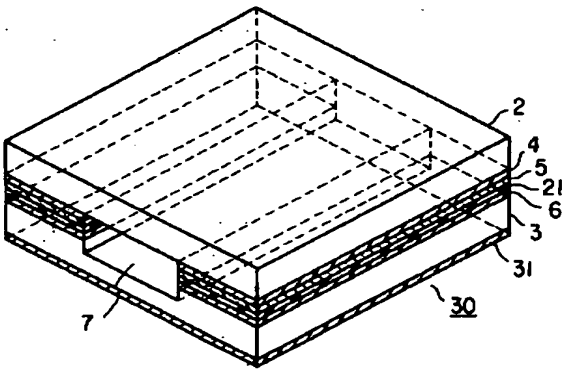
【図２】


(a)
4
2
(b)
5
4
2
(c)
8
5
4
2
(d)
8a
5
4
(e)
9
8a
5
4
2
(f)
5
10
4
2
(g)
6
3
(h)
11
6
3

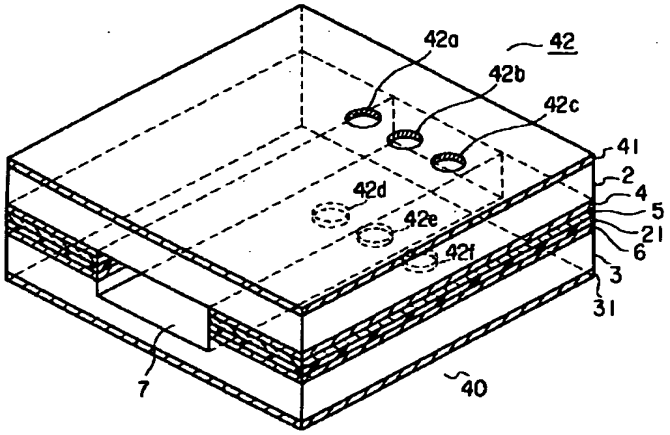
【図３】


(a)
11a
6
3
(b)
11a
6
3
(c)
6
3
(d)
12
6
13
3
(e)
10
13
7
(f)
4
5
6
1
7

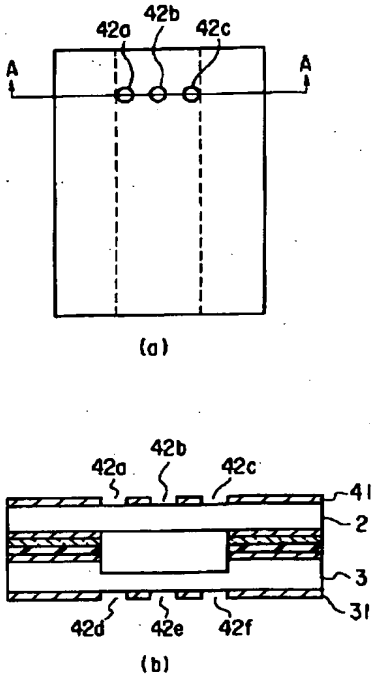
【図５】


2
4
5
21
6
3
31
30
7

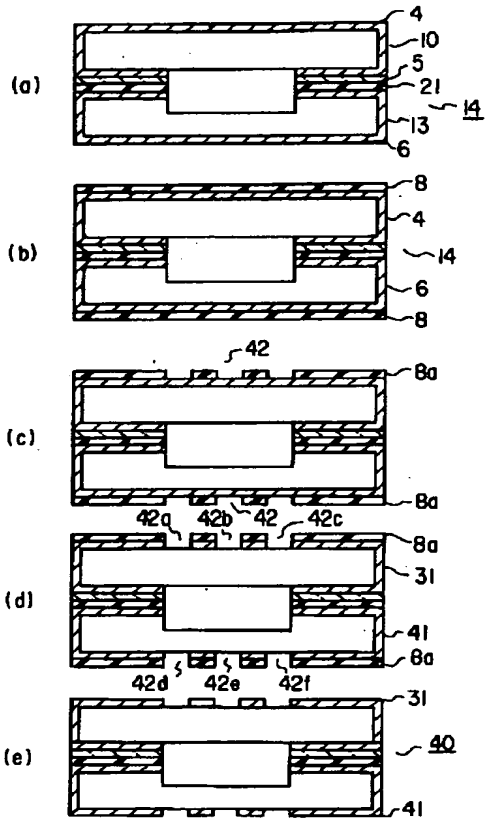
【図６】


42a
42
42b
42c
41
2
4
5
21
6
3
31
42d
42e
42f
7
40

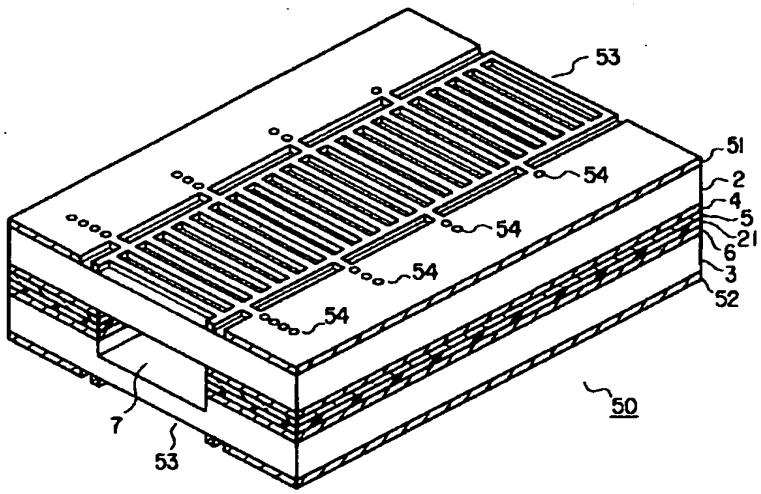
【図７】


42a
42b
42c
A
A
(a)
42a
42b
42c
41
2
3
31
42d
42e
42f
(b)

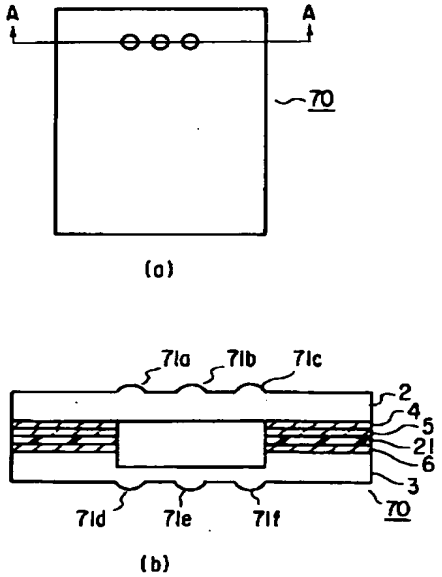
【図８】


(a)
4
10
5
21
14
13
6
(b)
8
4
14
6
8
(c)
42
8a
8a
(d)
42a
42b
42
42c
8a
31
41
8a
42d
42e
42f
(e)
31
40
41

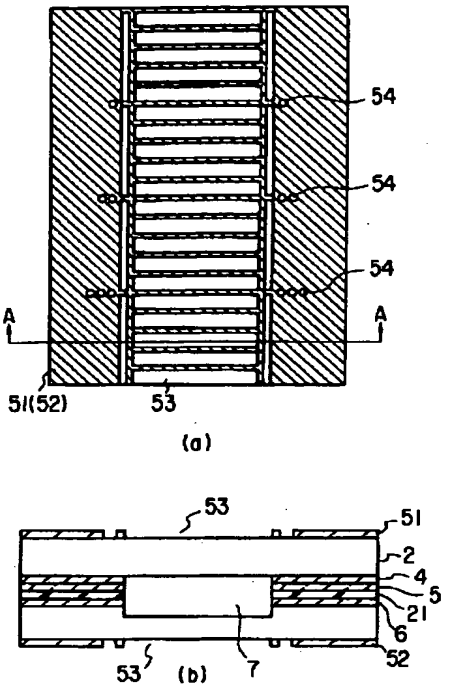
【図９】


53
51
54
2
4
54
5
21
54
6
3
54
52
50
7
53

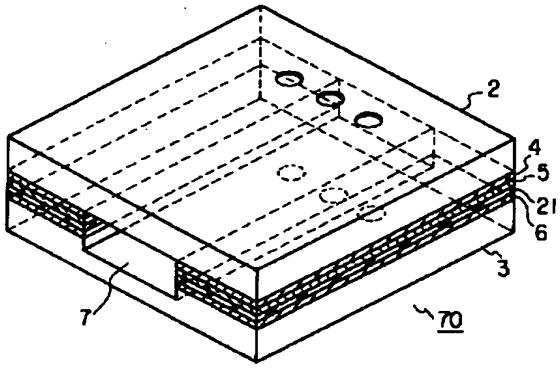
【図１３】


A
A
70
(a)
71a
71b
71c
2
4
5
21
6
3
71d
71e
71f
70
(b)

【図１０】



【図１２】



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　G01N　21/05
　H01L　49/00
【ＦＩ】
　G01N　21/05
　H01L　49/00

【手続補正書】
【提出日】平成１４年３月１９日（２００２．３．１９）
【手続補正１】
【補正対象書類名】明細書
【補正対象項目名】特許請求の範囲
【補正方法】変更
【補正内容】
【特許請求の範囲】
【請求項１】　対向する側の少なくとも一方面に流路を形成する溝が設けられる一対の石英ガラス基板と、
前記一対の石英ガラス基板の対向する側の面で、前記溝内面に接する面を除き、対峙する面上に形成される一対のシリコン層と、
前記一対のシリコン層間に介在し、両シリコン層に接して形成されるアルカリイオン含有ガラス層と、
を具備し、一体的に接合されることを特徴とする微小流路素子。
【請求項２】　対向する側の少なくとも一方面に流路を形成する溝が設けられる一対の石英ガラス基板と、
前記一対の石英ガラス基板の対向する側の面で、前記溝内面に接する面を除き対峙する面上に形成される一対のシリコン層と、
前記一対のシリコン層間に介在して、一方のシリコン層に接して形成されるアルカリイオン含有ガラス層と、
前記一対のシリコン層間に介在して、他方のシリコン層及び前記アルカリイオン含有ガラス層とに接して形成されるシリコン酸化膜と、を具備し、一体的に接合されることを特徴とする微小流路素子。
【請求項３】　前記微小流路素子の石英ガラス基板の非接合面側の一方の面に光反射層若しくは光吸収層のいずれか一方を設けたことを特徴とする請求項１若しくは、請求項２に記載の微小流路素子。
【手続補正２】
【補正対象書類名】明細書
【補正対象項目名】００１３
【補正方法】変更
【補正内容】
【００１３】
【課題を解決するための手段】本発明は上記目的を達成するために、対向する側の少なくとも一方面に流路を形成する溝が設けられる一対の石英ガラス基板と、前記一対の石英ガラス基板の対向する側の面で、前記溝内面に接する面を除き、対峙する面上に形成される一対のシリコン層と、前記一対のシリコン層間に介在し、両シリコン層に接して形成されるアルカリイオン含有ガラス層とを備え、一体的に接合される微小流路素子を提供する。
【手続補正３】
【補正対象書類名】明細書
【補正対象項目名】００１４
【補正方法】変更
【補正内容】
【００１４】さらにこの微小流路素子は、対向して接合する石英ガラス基板の非接合面側の少なくとも一方の面に光反射層若しくは光吸収層のいずれか一方を備える。